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Two More Standard Oil Co. Motor Tankers

Conversion of the 15,300 Tons d.w. Tankships "J. A. Moffett Jr." and "E. T. Bedford" with Twin-Screw Diesel Engines of 3000 s.h.p. at 90 r.p.m.

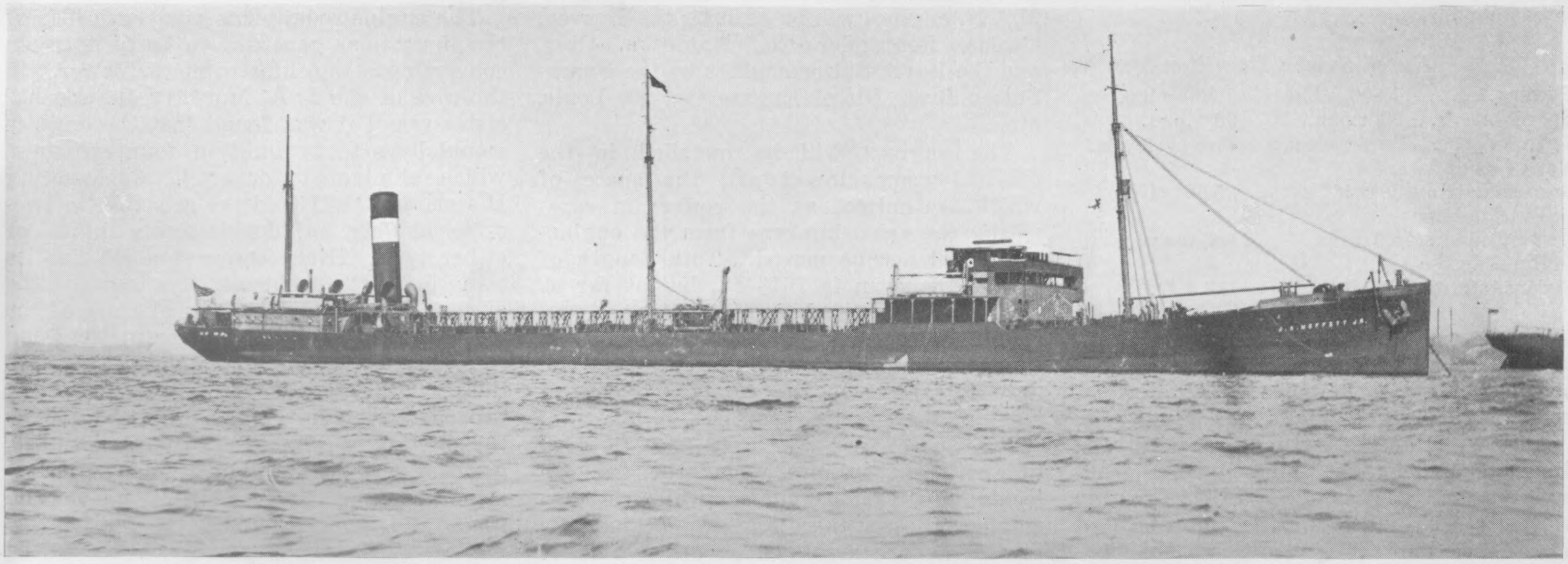
AT a cost of approximately $1,300,000 or $42.25 per deadweight ton, contracts have been placed with two East Coast shipyards by the Standard Oil Co. (N. J.) for the conversion of two large twin-screw tankers to Diesel power, namely the J. A. MOFFETT JR. and the E. T. BEDFORD, both vessels of about 15,300 tons d.w.c. Final choice fell upon two makes of two-cycle Diesel engines, namely the Busch-Sulzer and the Hamilton-M.A.N., the makers of which have both received orders for two 1500 s.h.p. four-cylinder units, together with the necessary auxiliary Diesel engines. This work, together with other conversion work now underway and contemplated, and with the forthcoming Shipping Board conversions of eighteen ships, is highly useful to the domestic shipbuilding, engine-building and marine equipment industries at this time, and probably will save some of the yards from closing down.

During the last two years the Standard Oil Co. (N. J.) and its foreign subsidiaries have gone in heavily for the Diesel form of propulsion, the number of new motor-tankers and conversions recently ordered or placed in service now amounting to 19 craft aggregating 231,667 tons d.w. and 53,000 s.h.p.

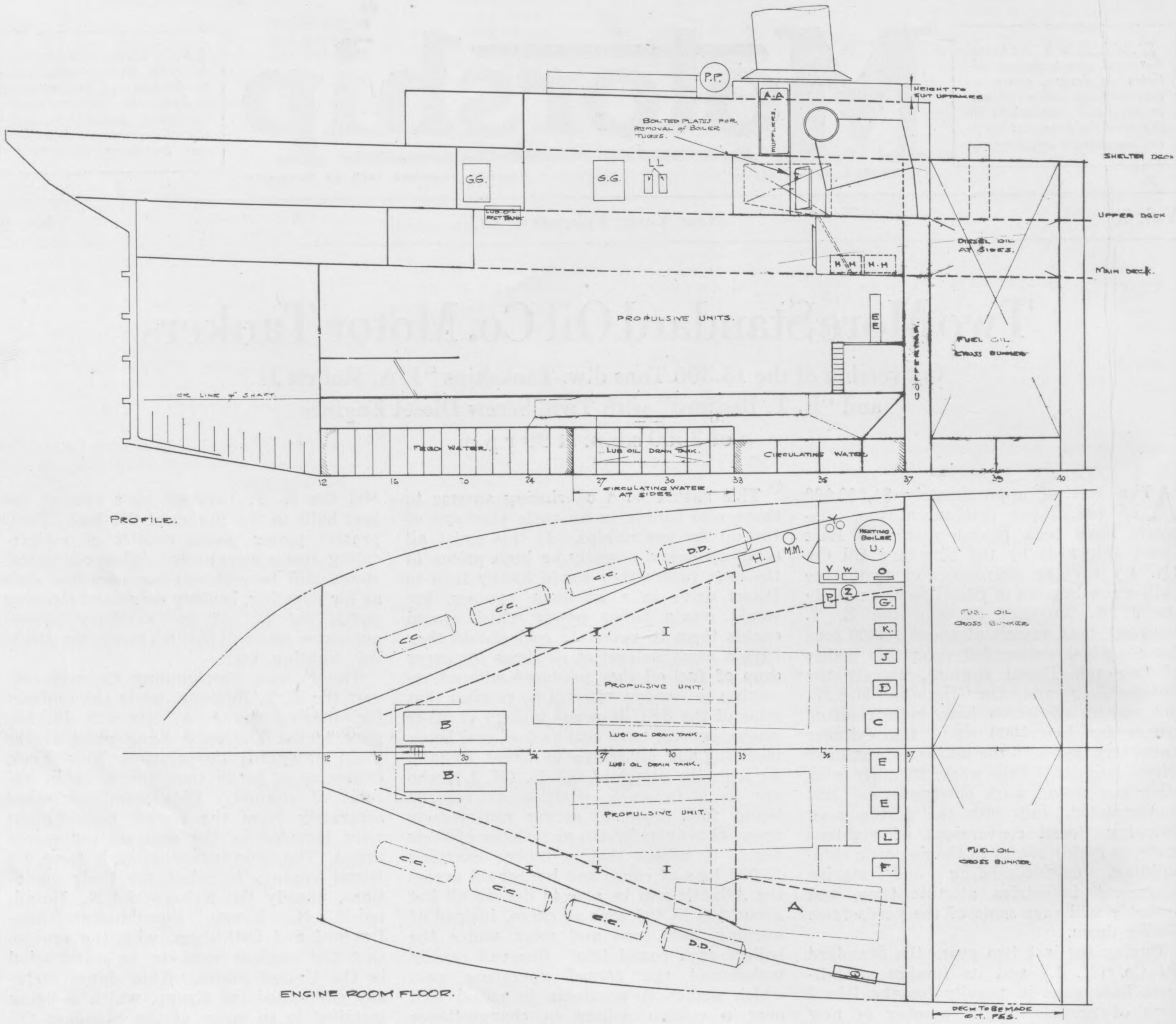
This should be a convincing answer to those who believe in an early shortage of fuel-oil for motorships. If this great oil company saw a scarcity or high prices in the near future they would hardly turn to Diesel drive in a wholesale manner, but would retain boiler power which would enable them to revert to coal should they have a ready market at all times for every drop of fuel oil they produced without resorting to storage. It will be recalled that some of the British owned tankers of other companies still burn coal as fuel, coal being plentiful and oil scarce in Great Britain. As it is, the Standard Oil Co. (N. J.), who are in a favorable position as regards liquid fuel, hope to secure considerable financial benefits by the motorizing of their fleet. It means that a tanker carrying 15,000 tons of cargo and bunker oil across the Atlantic will be able to deliver all but about 300 to 400 tons as cargo, instead of burning 1000 tons and more under the boilers each round trip. One can readily understand the annual operating gain which makes it profitable to spend well over a million dollars to change these steamers, which were only built three years ago.

Built in 1921 at the Federal Shipyard at Kearny, N. J., the J. A. MOFFETT JR. and the E. T. BEDFORD have two of the best hulls in the Standard Oil fleet. Their present power plants consist of reciprocating steam machinery. When converted, steam will be retained for port use such as for pumping, heating cargo and cleaning tanks, but at sea the auxiliary Diesel-generator sets will furnish power for steering, lighting, etc.

The Federal Shipbuilding Co. will convert the E. T. BEDFORD, while the contract for altering the J. A. MOFFETT JR. has gone to the Tietjen & Lang plant of the Todd Shipyards Corporation, New York, deliveries to be in four months after receipt of engines. Bids were not asked separately from the engine builders but were included in the contract conversion prices. The shipyards were each given six Diesel engines to select for their quotations, namely the Nelseco-M.A.N., Hamilton-M.A.N., Krupp, Busch-Sulzer, Sun-Doxford and Bethlehem, with the proviso that the engines were to be constructed in the United States. This clause virtually eliminated the Krupp, which is being installed in so many of the Standard Oil tankers and in the three other conversions JOSIAH MACY, S. B. HARKNESS and TRONTOLITE, as the Krupp engine is not yet being built in this country. Following are a few



J. A. MOFFETT JR., one of the two 15,300 tons d.w. reciprocating steam-driven tankers about to be converted to twin-screw Diesel power for the Standard Oil Co. (N. J.)



Engine-room inboard profile and plan of the J. A. MOFFETT JR. class tanker, showing the space available for the Diesel engines and auxiliary machinery

general details of the engines as provisionally planned and finally selected for these latest conversions:

	Busch-Sulzer	*Hamilton-M.A.N.*
Power	1,500 s.h.p.	1,500 s.h.p.
Speed	90 r.p.m.	90 r.p.m.
Type	Two-cycle s. a.	Two-cycle s. a.
No. of cylinders.	4	4
Bore and stroke.	30"x42"	25.59"x47.25"
Daily fuel-consumption	6.9 tons	6.6 tons
Daily lubr. oil consumption.	108 lb.	158.4 lb.

These engines are to be delivered in ten months. For auxiliary power there will be in each ship one Diesel-generator set of 300 kw. and two smaller oil-engine sets.

The two hulls are virtually identical, the dimensions being the same and the deadweight tonnages being 15,292 for the MOFFETT and 15,319 for the BEDFORD, but of course, the changes due to the conversion may alter the tonnages somewhat. Their registered dimensions are: Length, 499.2 ft.; breadth, 68.1 ft.; depth, 30.5 ft.; gross tonnage, 9564 tons. The Hamilton-M.A.N. engines will be built by the Hooven, Owens, Rentschler Co., Hamilton, Ohio, and the Busch-Sulzer engines by the Busch-Sulzer Bros. Diesel Engine Co., St. Louis, Mo.

The engines will be installed in the original compartment aft, the space of which is limited, as the cofferdam separating the cross bunkers from the engine-room will not be moved. Total length of the engine-room is 76½ ft., but as far as the installation of the main engines is concerned only about 45 ft. is available due to narrowing of the hull aft and to the flat forward. On the forward starboard side of the engine-room is the big auxiliary Diesel-generator set, and forward of the main engines under the flat are located the various pumps, while the two smaller Diesel-generators are located aft. Air flasks are arranged on either side of the engine-room. Fuel oil and lubricating oil will be passed through centrifugal purifiers before feeding to the main engines.

The engine-room plans give some idea of the limitations generally to be faced when converting steamships to motor power. In the case of the J. A. MOFFETT JR. and her sister vessel it was found that the engines would have to be built in four cylinders, which eliminated four-cycle single-acting Diesels and restricted the selection to two-cycle engines or double-acting units of either type. Every conversion job has its own distinct problems. Sometimes the owner finds it desirable to make use of the opportunity to instal higher power and thus secure better ship's speed and for that purpose may be willing to incur the expense of structural alterations such as the shifting of a bulkhead. In an oil tanker, however, two double-riveted bulkheads must be moved in order to lengthen an engine-room, and that is a much more expensive matter. This explains why the Standard oil boats are being converted with the engine-room space unaltered.

Diesel-Drive for Ten Coast Guard Patrol Boats

Treasury Department Orders Diesel Engines of 300 s.h.p. in the New Patrol Boats of 210 Tons Displacement

SOME months ago orders were placed by the Coast Guard Service for a huge fleet of high-powered gasolene patrol boats. While these boats are valuable on account of their high speed, especially for close to shore work, the price of fuel renders them a very expensive proposition for rum-chasing work, and their life will be short. Where high speed is of less importance, much saving can be effected by the use of oil engines. This has evidently been realized by the Coast Guard Service who recently called for bids for ten 100 ft. patrol boats to have Diesel engines for their propulsion. The general dimensions of the boats are to be as follows:

HULL DETAILS

Length bp.	98 ft.
Beam md.	23 ft.
Depth md.	11 ft. 8⅝ in.
Draft, mean	7 ft. 6 in.
Draft, max.	8 ft.
Displacement (full-load conditions)	210 tons

These dimensions are larger than those of the biggest gasoline-driven patrol boats, which are 75 ft. between perpendiculars, but they will be of slower speed since the engine power is to be 300 instead of 400 s.h.p. as in the case of the gasolene motors. Whereas the earlier craft were of wood, the new boats will be entirely of steel with the exception of the decks and wheelhouse.

The engine-room will be amidships; only 17 feet length has been allowed which necessitates the use of compact high-speed engines. A large forecastle will be forward of the engine-room, containing accommodation for eight of the crew. Aft of the engine room will be a galley and messroom, two cabins and a lazarette. The deckhouse and wheelhouse will be forward of amidships.

The engines are required to be a standard commercial product and of American manufacture. The following is an extract from the engine description:

"The engine will be a marine vertical inverted engine having preferably six cylinders, but in no case less than four cylinders. It will be of the full Diesel four-cycle type of operation with air injection, and will develop 150 b.h.p., and the operating speed for developing this power will be not less than 350 revolutions per minute. The engines will be of simple design and rugged construction to ensure durability, ease of operation and long life in service.

"The weight of such a unit, including the reverse gear and all attached accessories, shall not exceed 14,000 pounds. The engines will be built in pairs, one right-handed and one left-handed, to drive outboard turning propellers. The operating station will be at the engine and convenient for one man control.

"A mechanical reverse gear and clutch of satisfactory design and workmanship and adequate in size and area will be furnished with each engine. It will be built-in so as to form a unit power plant."

Probably the light weight specified, and the provision of a separate reverse gear to be included in this weight is the most difficult condition to fulfill, particularly to combine with the rugged construction which is called for. The demand for a reverse gear comes rather as a surprise since in the present day the majority of marine engines of this power are directly reversible.

It was mentioned that the following points would receive special consideration:

(a) Conformity with specifications.

(b) Excellence of design.

(c) Experience of the builder in producing engines of the same or similar design.

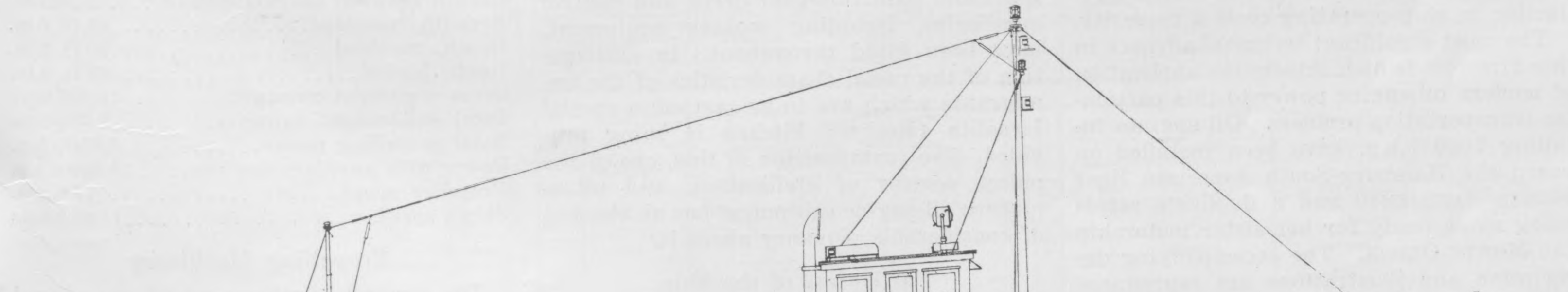
(d) The number of engines of same or similar design produced by bidder and now in successful operation.

(e) Weight.

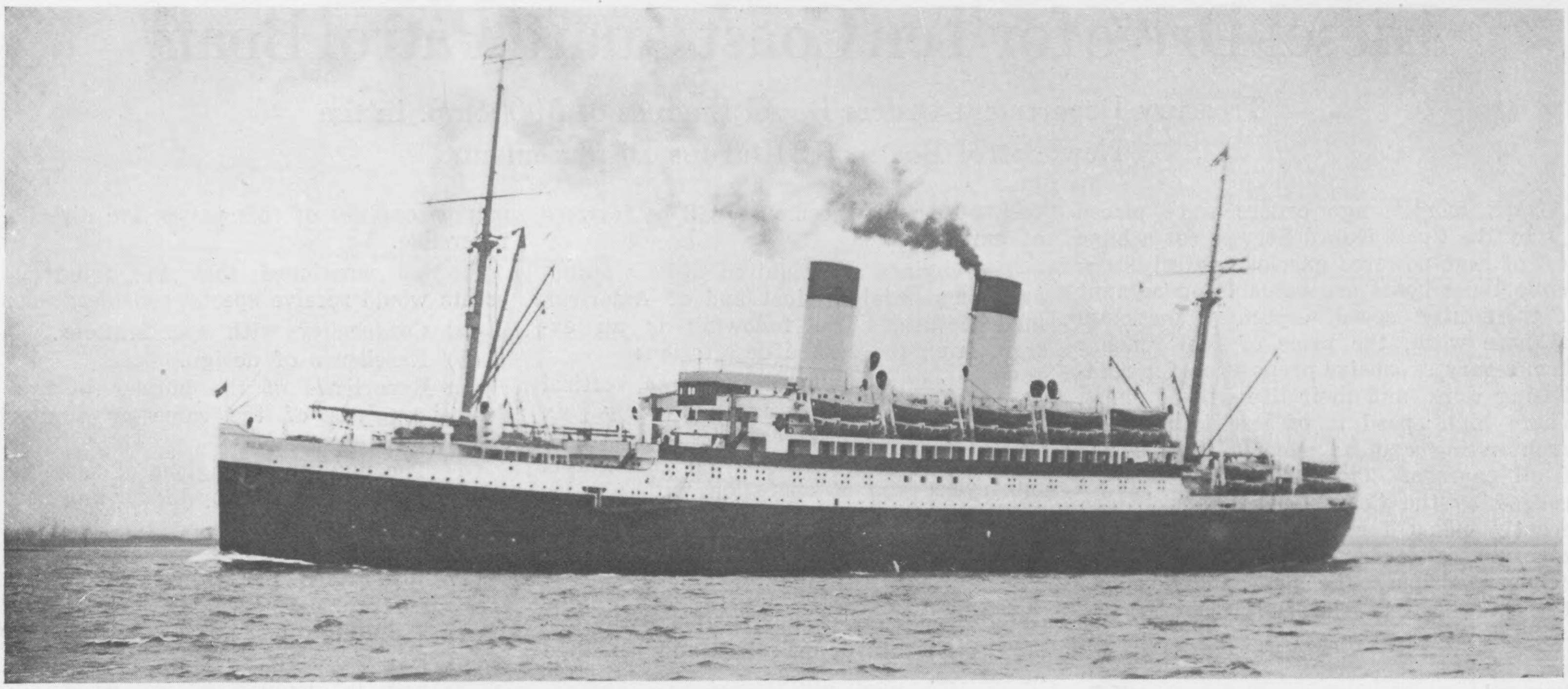
(f) Revolutions per minute at which rated power is developed.

(g) Installing dimensions.

The order for these engines has been placed with the Winton Engine Works of Cleveland, Ohio, for twenty of their four-cycle engines. The auxiliary machinery is to include a 12 h.p. Bulldog oil engine direct coupled to a 32-volt d.c. generator of about 8-kw. capacity. This will supply current to the motors, which will drive the fuel transfer pump, the fire pump and other auxiliaries. The contract for the generating sets has been let to the Bates & Edmonds Motor Co. of Lansing, Mich. Auxiliary compressors of Winton make are included in the equipment. Circulating water and lubricating oil pumps are to be mounted on the main engines. Five 6-volt and one 2-volt storage battery are to be provided for the 32-volt lighting circuits. The usual requirements in the way of fuel and lubricating oil tanks and air bottles are made. Contract for the hulls has gone to the Defoe Boat Company at a cost of $405,800, inclusive of the installation work.



Outboard profile of one of the ten 100-ft. Diesel-driven patrol boats building for the U. S. Coast Guard



Passenger liner MONTE SARMIENTO under full headway. She is driven by geared oil engines and will carry only emigrants from Germany to South America

Gear Drive Diesel Liner "Monte Sarmiento"

Propelled by Trunk-Piston Engines Aggregating 7000 s.h.p. with Supercharging—Auxiliary Engines Total 3400 s.h.p.

As one of the many things which was profoundly affected by the outcome of the World War, the transportation of immigrants is a subject of first-rate importance both to the New and the Old World. What the broader implications of recent developments may be is being keenly studied by many; but as far as more immediate matters such as the design and powering of ships suitable for immigrant travel are concerned, definite happenings of a concrete engineering nature have already taken place. The low fares and great distance from Europe to South America makes a reduction in ship operating costs a necessity.

The most significant technical advance in this direction is undoubtedly the application of modern oil-engine power to this particular transportation problem. Oil engines totalling 7000 b.h.p. have been installed on board the Hamburg-South American liner MONTE SARMIENTO and a duplicate set is being made ready for her sister motorship the MONTE OLIVIA. The accompanying description and illustrations are reproduced from *Werft, Reederei, Hafen,* by arrangement.

Both of these are modern passenger vessels specially designed for exclusively third-class immigrant travel between the European continent and South America. A drastic change in the immigration policy of the United States has considerably curtailed the transatlantic transportation of steerage passengers, and the upheaveal in international relations brought about by the World War has contributed its share toward a shift in immigrant travel in general.

Marked successes have been achieved by the one-class passenger vessels, wherein, although the accommodations are nominally of third-class quality, they are generally of a considerably better grade than those provided on ships where second and first-class accommodations are also furnished. Above all, the one-class ship wipes out class distinctions and, by giving all the passengers the entire run of the ship, adds materially to the pleasure which they get out of the voyage.

The most modern developments have also been taken into account in the choice of the MONTE SARMIENTO'S oil engine propelling equipment. High-speed trunk piston engines are used in connection with flexible-shaft and reduction-gear drive, and electric auxiliaries, including cooking equipment, have been fitted throughout. In anticipation of the racial characteristics of the immigrants which are to be carried, a special Israelite (Kosher) kitchen is being provided. The juxtaposition of this, one of the oldest devices of civilization, and ultramodern oil engine equipment has an element of considerable piquancy about it.

Particulars of the Ship

Also partly in deference to the wishes of the immigrants, twin dummy stacks are built in and there can be little doubt that they impart that characteristic steamship appearance without which the partly illiterate immigrants from central Europe hesitate to go to sea. According to the immigrant, the more funnels there are the more desirable is the ship.

In accordance with the general practice applying to one-class ships, the passengers are accommodated for the most part in cabins suitable for from two to eight persons apiece. Spacious social halls are provided and are divided into women's and smoking rooms, while the usual promenade decks are practically identical with those reserved for first and second-class passengers on liners of multi-class type. A total of 2470 passengers can be carried and in addition a carrying capacity of 4600 tons of cargo is allowed for. The crew of 249 persons includes 53 for the deck, 27 for the galley, 120 for service to the passengers, and 39 for the engine room. Of the latter, 10 are licensed engineers, 8 are juniors, 6 electricians and mechanics, and 15 oilers.

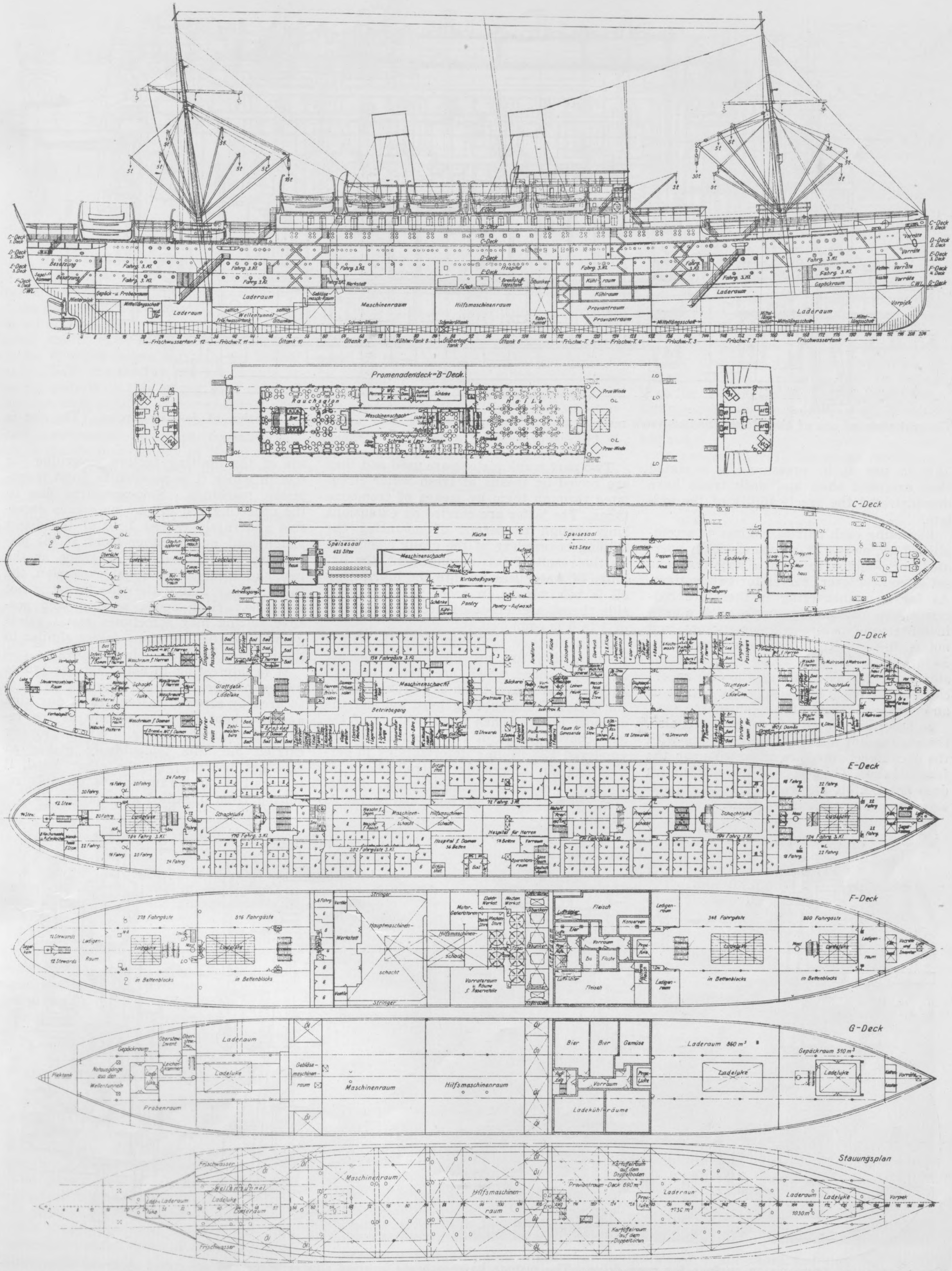
The general dimensions of the MONTE SARMIENTO are as follows:

Class and society	Germanischer Lloyd
Length over all	524 ft.
Length between perpendiculars	497 ft.
Breadth, moulded	65 ft. 6 in.
Depth, moulded	50 ft. 2 in.
Draft, loaded	26 ft. 9 in.
Gross registered tonnage	13,628 tons
Total deadweight capacity	8,600 tons
Total propelling power	7,000 s.h.p.
Power with auxiliary engines	10,400 s.h.p.
Propeller speed	77 r.p.m.
Ship's speed	14.25 knots

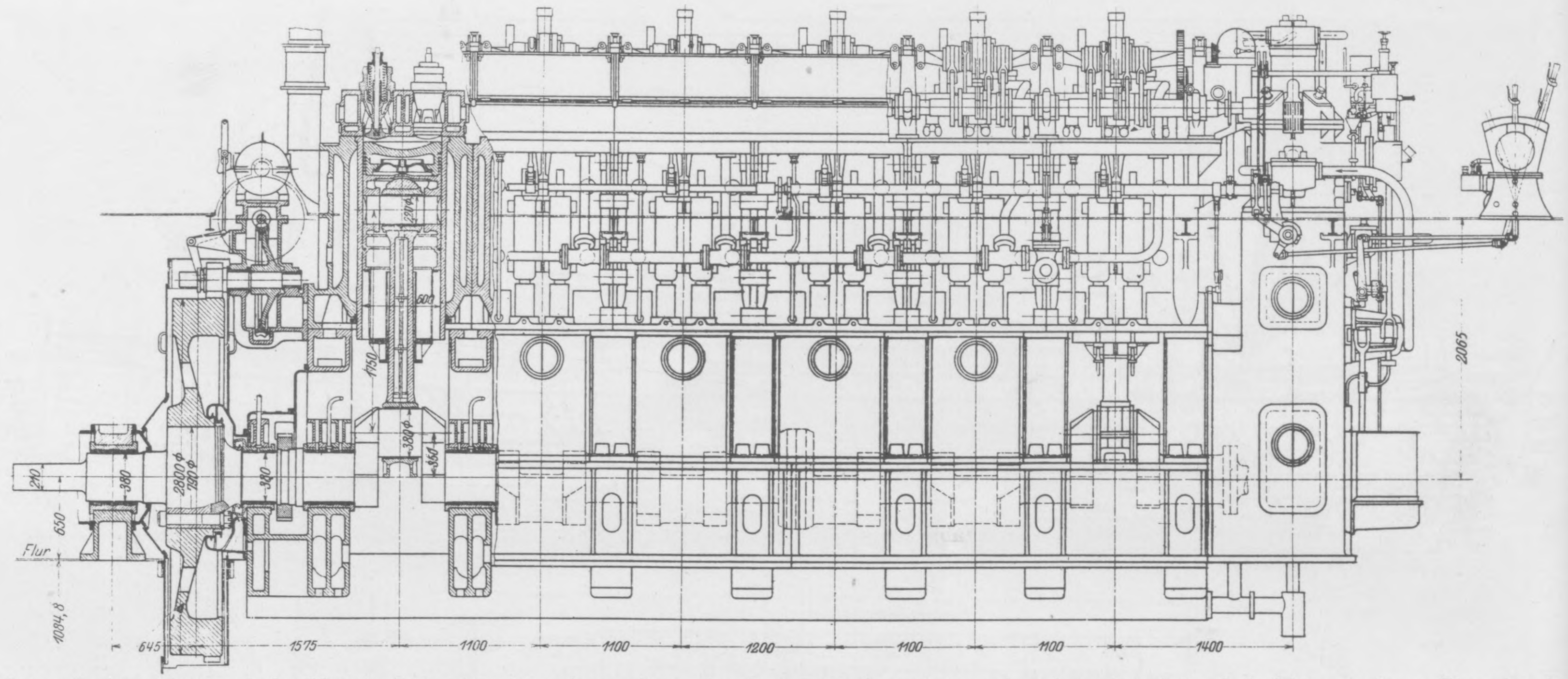
Propelling Machinery

The general arrangement of the geared oil-engine drive is shown in the illustration. There are twin screws driven by four Blohm & Voss direct-reversible trunk-piston engines with bore and stroke dimensions of 23.62 by 27.56 inches and running at 215 r.p.m. The engines are geared in pairs to each of the propeller shafts, each of which transmits 3500 h.p. at 77 r.p.m.

Each of the six-cylinder engines was originally rated to contribute 1350 net h.p. to the propeller shafts, but by the use of supercharging, this output has been increased to 1750 per unit. For the supply of supercharging air three Brown-Boveri blowers, electrically driven at 2500 r.p.m., are provided and their capacity is 9180 cu. ft. per minute each. They deliver air to the intake valves of the Diesel engines at about



Deck and arrangement plans for motor liner MONTE SARMIENTO, accommodating 2,719 passengers and crew



General view of one of the MONTE SARMIENTO'S main engines, showing reversing gear and unique location of jacking engine. The size is revealed by a glance at the control levers

15½ lb. per sq. in. pressure. It is stated that extended shop and dock trials have demonstrated the practicability of the system.

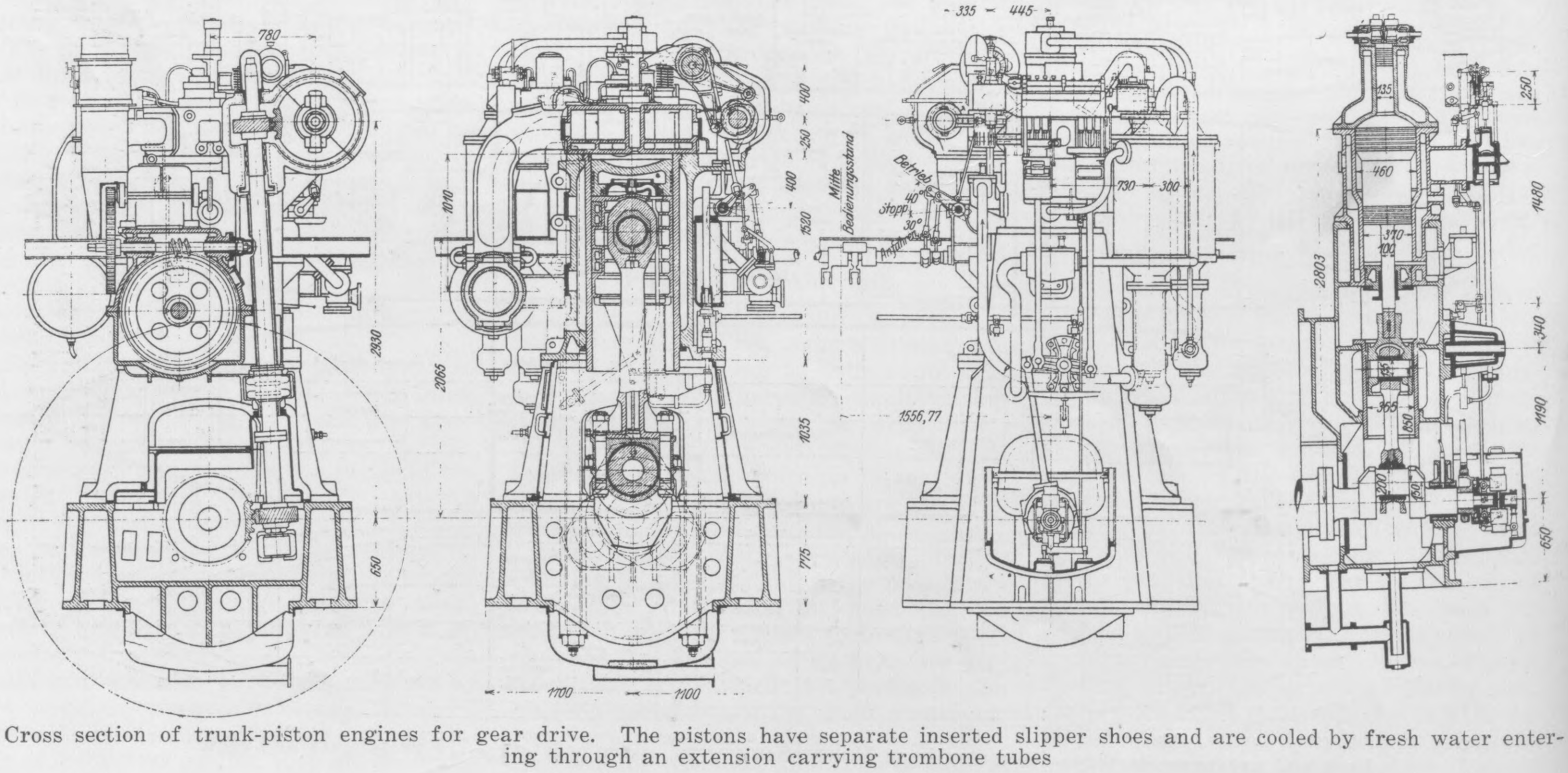
Reversing each pair of engines is accomplished by means of a pneumatically-operated servo-motor in such a way that one set of control levers serves for two engines. As far as maneuvering is therefore concerned, we are dealing simply with a twin installation of twelve-cylinder engines, and not with a quadruple engine arrangement. Reversing is brought about by one of the standard systems of lifting the cam rollers clear of the cams long enough to permit of an endwise shifting of the camshaft.

In accordance with current practice, also, the compressor and fuel pumps, along with the jacking engine, are mounted near the forward ends. The design of this mechanism does not exhibit any radically new departures from conventional systems.

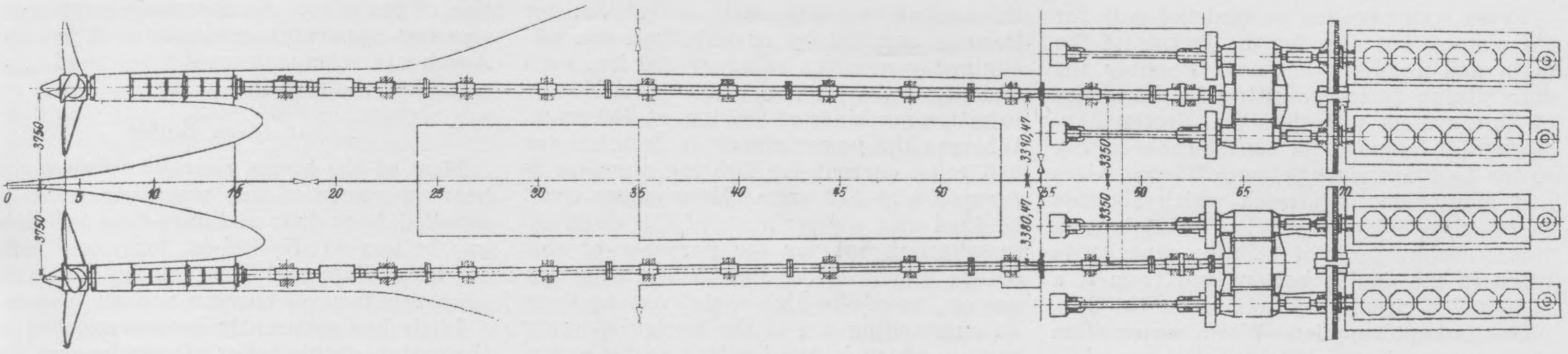
Two-part trunk pistons are used and they are cooled by means of fresh water circulated through them by means of trombone tubes. The latter are carried on extensions long enough to permit of mounting the stuffing boxes clear of the crank chambers. As the result of this arrangement, the liability of water leaking into the lubricating oil is minimized. In order to keep down side thrust a crank-to-connecting-rod ratio of 1 to 5 is employed.

As a further protection for the trunk pistons, they are provided with separate babbitted shoes which are like crosshead slippers and prevent the cast-iron body of the piston from rubbing hard against the cylinder liner. When trunk pistons of the size characteristic of this installation are employed (23 ⅝ in.) deformations in service are not so readily controllable as in smaller machines. In fact, piston distortion brought about by heat and stress is one of the limiting factors governing the size in which it is possible to build trunk-piston machines. Side-pressures due to the conecting rod are by no means excessive and rarely exceed 1/10 of the direct piston load, on the other hand, if the piston has been pulled out of shape as the result of inequalities in eat expansion, the full area for taking the side thrust is not available. High spots, scoring, and possibly seizing may sometimes result unless guarded against by some device similar to the inserted babbitted shoes shown.

It is interesting to note that the bronze halves of the wrist-pin bearing are not secured by screwed fastenings of any kind and are kept in place merely as the result of accurate fitting. When properly carried out this undoubtedly makes an excellent bearing; on the other hand, it is sensitive to derangements possibly resulting from unskilled attendance.



Cross section of trunk-piston engines for gear drive. The pistons have separate inserted slipper shoes and are cooled by fresh water entering through an extension carrying trombone tubes



General arrangement of engines, gears and shafting for Diesel passenger liner MONTE SARMIENTO

As is shown in the drawings reproduced by arrangement with *Werft, Reederei, Hafen,* the engines do not drive the pinions of the gear reductions directly, but are connected to the latter by means of flexible and hollow shafts. The shaft leading from the engine flywheel passes through the hollow pinion shaft and the two are joined only at the far end. With this system it is claimed that the transmission of harmful torsional oscillations from the engine to the gear teeth is prevented. In a paper recently read before the German Society of Naval Architects Dr. Frahm described measurements made by means of indicating torsiographs which tended to show that the torsional oscillation actually transmitted by an arrangement of this kind can be prevented from becoming serious. The function of the long flexible shaft may be compared to that of a spring buffer, similar in operation to the coiled springs used for protecting rudder quadrants against shocks transmitted from the rudder stock. Somewhat the same principle is made use of by The Falk Co. of Milwaukee, which interpose spring couplings between the flywheels of its oil engines and the rear reductions belonging to them.

Each of the flexible shafts may be disconnected at the coupling from the hollow pinion shaft surrounding it, a provision which makes it possible for one or two of the main engines to be out of commission while repairs are carried out. The gear faces are 23⅝ in. wide, while the pitch diameters and numbers of teeth are respectively 32.21 in., 124 teeth, and 90.36 in., 348 teeth, the helical angle being 45 deg. A single-collar thrust bearing with tilting blocks is mounted in the housing close to the large gear.

Because of the relatively high speed at which the engines run and the considerable inertia effect of their moving parts a brake is provided for the purpose of bringing them promptly to rest. Quick stopping such as would be desirable for answering a rapid succession of bells, is the object sought after in providing this accessory.

Dr. Frahm on Gear Reductions

General considerations affecting the use of gear drives were recently discussed by a well-known German authority on naval architecture on the occasion referred to above. We translate as follows:

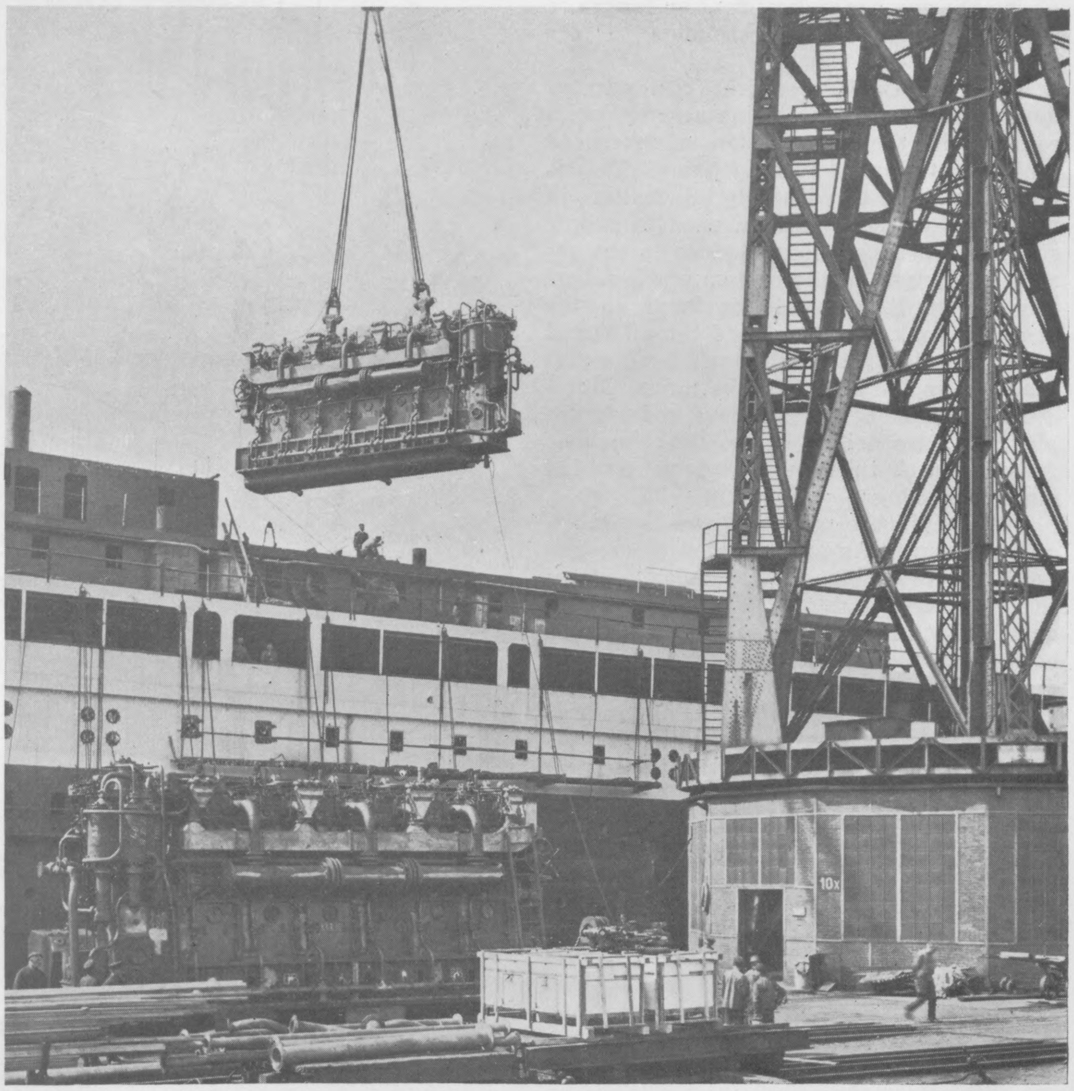
"The advantages which are offered by the indirect drive are illustrated by the example shown in the accompanying figure. On this diagram several motor-drives for a single-screw cargo vessel of 2000 s.h.p. are compared; they consist of a direct-connected four-cycle engine, a four-cycle geared installation, and two direct-drive two-cycle units, of which one is single and the other double-acting.

"The figures for weight and cost shown in the table apply for each complete installation including thrust-block. For the purposes of an exhaustive comparison it is to be borne in mind that minor differences with respect to the propellers and shafts result according to the type of drive which is chosen. Since these variations are slight, however, they are not taken into account in the following estimates.

"It is further to be noted that scavenging blowers for the two-cycle engines have not been considered. In the case of modern installations it would be generally found that the blowers are separated from the main engines and are driven by electric motors. If a sufficient number of spare Diesel generators necessary for supplying them is allowed for, the conclusion may be drawn that the scavengers and extra Diesel generators require the addition of 22 tons' weight and involve an extra expenditure of $39,400.

"A general survey hen yields the following:

	4-Cyc. S.A. Direct A	4-Cyc. S.A. Geared B	2-Cyc. S.A. Direct C	2-Cyc. D.A. Direct D
Weight	430 tons	216 tons	289 tons	177 tons
Price (converted gold marks)	$100,000	$69,600	$79,350	$51,400
Propeller Speed	95 r.p.m.	235/70	85	75
Piston Speed	840 r.p.m.	840	669	590
Swept volume	152.2 cu. ft.	60.2	81.7	49.0



Assembly of trunk piston engines can be completed in the shops and they can be installed on the ship as a finished unit. Note the electric cooking stoves in the foreground

Fresh water cooling is used not only for the pistons, but also for the jackets of the main and auxiliary engines. Possibly the determining factor resulting in the choice of this system was that the MONTE SARMIENTO is intended for considerable sailing in the La Plata river between Buenos Aires and Montevideo, a stretch which abounds in muddy shallow places. A special fresh water cooling tank of 82 tons capacity is fitted in the double bottom and from it a 1580-gallon circulating tank under the floor plates is kept supplied. Warm water from the engines drains into the latter and is delivered from there by means of centrifugal pumps through coolers back to the engines.

Two vertical circulating water coolers of 3230 sq. ft. of surface each are installed. Sheet copper is used for the shells of these coolers and the partitions and tube sheets are made of bronze. Thick-walled condenser tubes are arranged to give the water eight passes through the apparatus, and it is intended that the temperature of the water supplied to the engines shall not exceed that of the sea water by more than 18 deg. Fahr.

Gravity Lubrication and Fuel Supply

Four daily supply tanks are provided for the main engines and two for the Diesel-generator sets, and the capacity of all of them is sufficient to keep the units which they supply running for more than 24 hours. In accordance with modern practice, liquid meters are inserted in the lines supplying the engines and calibration tanks are available for periodic checkings of the meter accuracy.

An interesting departure from current designs of forced lubrication arrangements consists in the substitution of overhead tanks for the usual forcing pump. This is not to be confused with drip lubrication, in which an overhead tank is used to supply sight-feed droppers located close to the various bearings. In the system employed on the MONTE SARMIENTO the leads to the overhead tank are closed and the oil is fed under practically the full static head corresponding to the height of the tanks. Moreover the crankshaft, connecting rods, wrist-pins, etc., are drilled in the usual manner for conducting the oil under pressure to the moving bearings.

Underneath the main engines two lubricating sump tanks are provided for receiving the lubricating oil which drains from the bearings, and two electrically-driven gear pumps having a capacity of 250 g.p.m. each return it to the overhead tanks already referred to. Meters are used to check the flow of lubricating oil, and a centrifugal purifier is employed for its reclamation.

An interesting connection may be observed between this lubricating arrangement and the characteristics of the geared trunk-piston engines. Because of their greatly reduced height, the highest of the important bearings to be lubricated — the wrist pins — are still so far below the overhead tanks that they will be supplied with oil under adequate pressure. Were it not for this fact it is doubtful whether the use of direct forcing pumps could be dispensed with.

Auxiliaries

As has already been mentioned, electric engine-room and deck auxiliaries are used throughout the ship, and the current for them is supplied by no less than five oil-engined generators rated at 450 kw. each and powered with six-cylinder M.A.N. air-injection machines of 680 h.p. at 250 r.p.m. Whereas the power circuit is designed for 230 volts, current for lighting purposes is furnished at 110 volts. Many pages could be filled with a description of this electrical installation, but for the purposes of this article it will be possible to touch on only one or two of the high spots. Among these an outstanding one is the electric steering engine, which is fitted with a motor-generator aggregate arranged for the Ward-Leonard system of control. Power for the steering motor is not taken directly from the line, but is furnished by a motor generating set running at constant speed. Whereas the motor of the generating set is of the normal shunt-wound type, the generator is separately excited with current taken from the main line. Resistance in the excitation circuit is controlled from the pilot house and by changing the voltage and direction of the steering motor current, makes possible a sensitive manipulation of the tiller. An automatic gyroscopic steering apparatus manufactured by the Anschuetz company may be used for actuating the steering wheel.

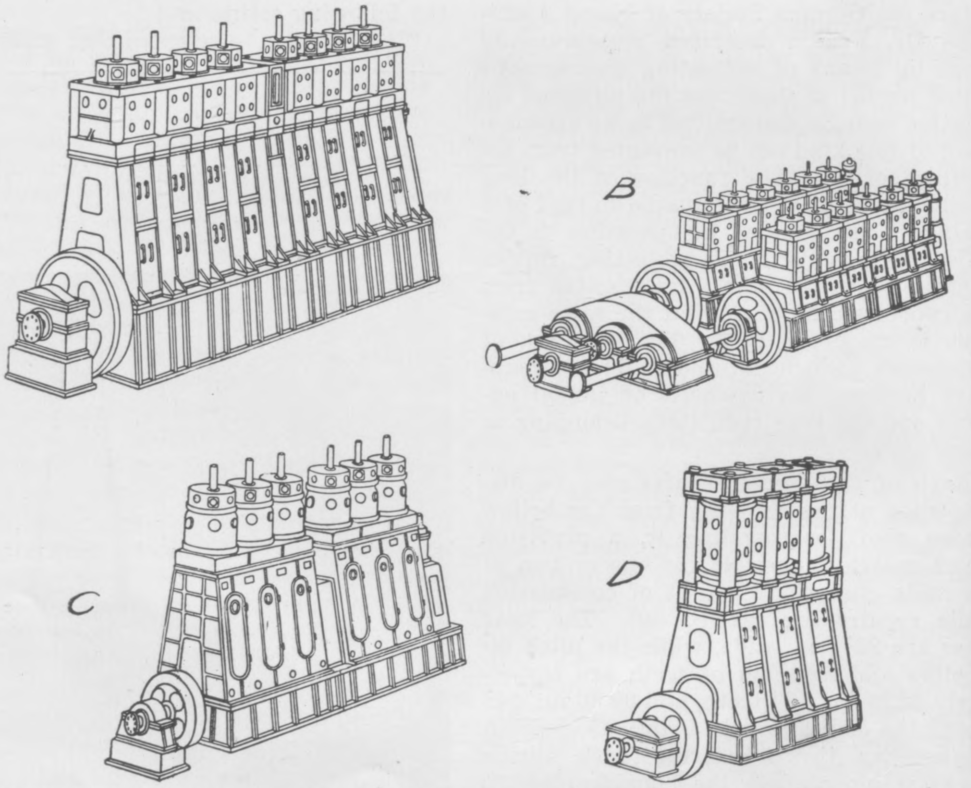
Exhaust-Gas Boiler

Most of the steam required to meet the heavy demands of this passenger vessel is supplied from four auxiliary-fired exhaust-gas boilers 11 ft. 2½-in. long and 7 ft. 4½ in. in diameter. They are equipped with supplementary oil burners and air blowers.

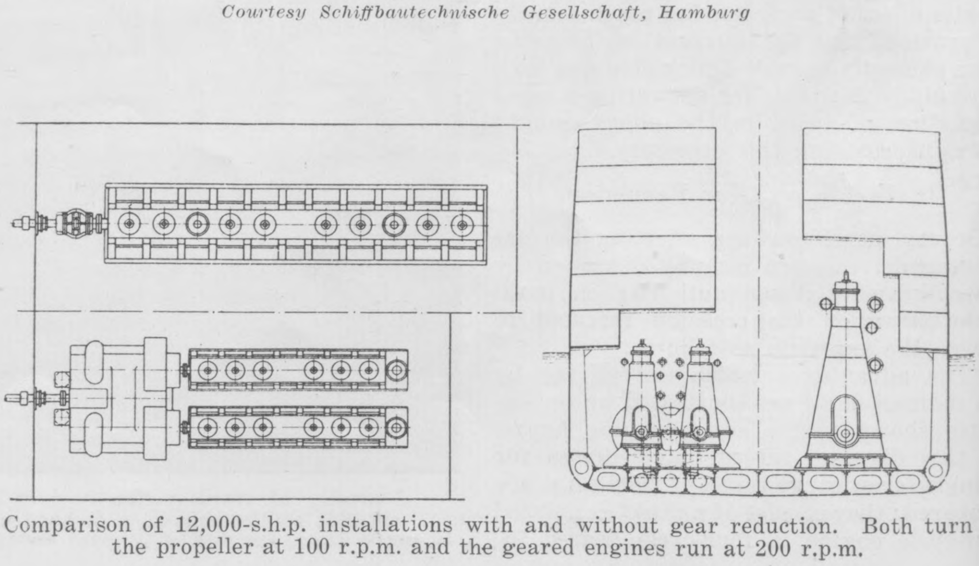
Little has apparently been overlooked in the design of this boiler. It can be used for generating steam at 120 lbs. pressure by means of exhaust gases or by oil-burning and in addition to that it is equipped with an air pre-heater and a feed-water heater. All that appears to be missing is the superheater, and if the steam were to be used for power purposes this would no doubt be supplied.

Conclusion

It is not so long ago that opinions were expressed to the effect that Diesel engines would never be used to any great extent



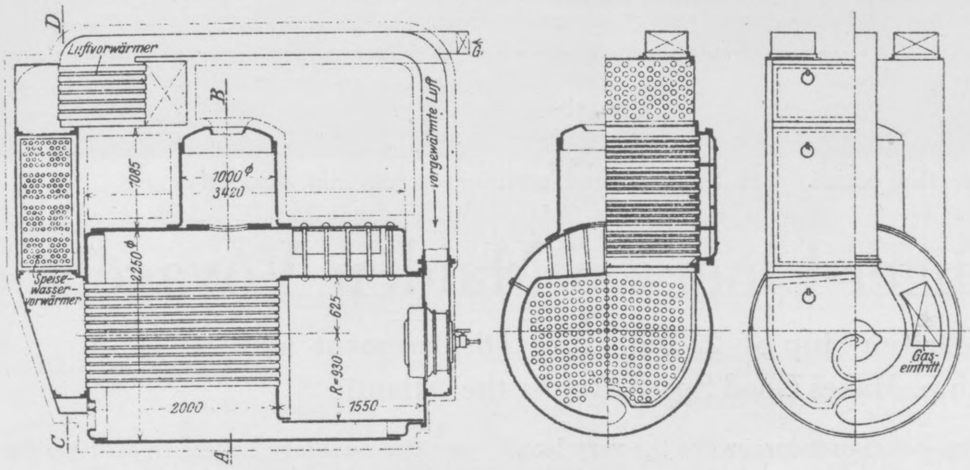
Perspective scale drawings showing comparison of 2000 s.h.p. oil engines for direct and gear drives. Upper left-hand corner, four-cycle single-acting; B, four-cycle single acting with gear drive (single screw); C, two-cycle single-acting; D, two-cycle double-acting.
Courtesy Schiffbautechnische Gesellschaft, Hamburg



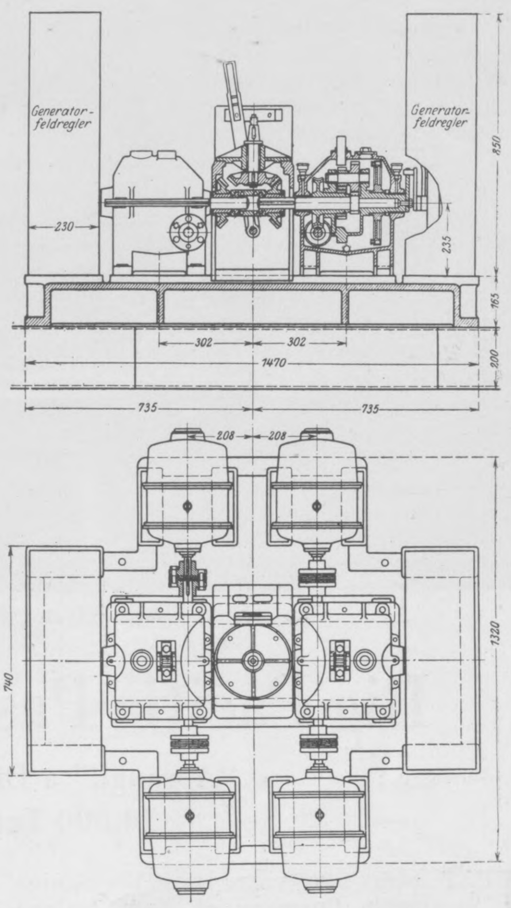
Comparison of 12,000-s.h.p. installations with and without gear reduction. Both turn the propeller at 100 r.p.m. and the geared engines run at 200 r.p.m.

for passenger vessels. Additional proof that this is not altogether correct is furnished by the foregoing limited description. It will be apparent, moreover, that the builders and owners of the MONTE SARMIENTO have burned their bridges behind them as far as the use of steam on this particular vessel is concerned. Unlike some others, they have made their ship a 100 per cent motor job, in the full confidence that this equipment is not to be superseded within the present generation. Their choice of the various available Diesel systems is an interesting combined technical and commercial selection.

As an example of an interesting method of treating the motorship cost problem the MONTE SARMIENTO installation deserves especial consideration. Shortly after the close of the war German interests were confronted with the choice of either using the surplus submarine engines in a commercial way or of having them demolished at the order of the Allies. Such a situation probably left little room for any unfavorable anticipations as to the suitability of the gear drives more or less dictated by the intrinsically high speed of the engines. That reduction gearing is now, however, being used for the MONTE SARMIENTO when the choice of high-speed machinery is a free one is a matter worthy of notice.



Four exhaust gas boilers like this supply large passenger vessel with steam. *Speise-wasser-Vorwärmer* = feed water heater. *Luftvorwärmer* = air pre-heater. *Gasein-titt* = gas inlet.



Ward-Leonard controlled electric steering engine on MONTE SARMIENTO. *Generator-feld-regler* = generator field controller

Two More Diesel-Electric Tugs for River Work

U. S. Engineer's Office Orders Modern Stern-Wheel Craft for Inspection Service. Winton Engines to Be Installed

CONSIDERABLE attention is now being paid by the U. S. War Department to constructing craft of the most modern type for service on our great rivers, and during the past few years several Diesel-electric and other oil-engined boats have been designed and put into operation by the various branches of the U. S. Engineers Office. The latest craft of this type to be ordered are two shallow-draft Diesel-electric tugs which will have sternwheel propulsion. One is for the Kentucky River and the other for Huntington, W. Va.

The following will be the principal dimensions of the boats:

Length, overall	85 ft. 2¼ in.
Length, md	70 ft. 0 in.
Breadth, extreme	17 ft. 0 in.
Draft, mean	2 ft. 6 in.
Power, at sternwheel	100 s. h. p.

Owing to the requirements of the point of delivery, bidding was necessarily confined to yards on the Mississippi and tributaries.

Below are the bids which have been received for the construction of the hulls:

The requirements for the main engine were that it should be a multi-cylinder vertical 4-cycle air-injection Diesel, capable of developing sufficient power to produce an output of at least 92½ k.w. continuously from the generator and exciter. All the bids specified Winton engines for the propelling equipment.

The generator will be of 85 k.w. capacity at 240 volts d.c., and the exciter of 7½ k.w. at 120 volts d.c. The propelling motor will be open type shunt wound and designed to develop 100 hp. at speeds between 300 and 600 r.p.m.

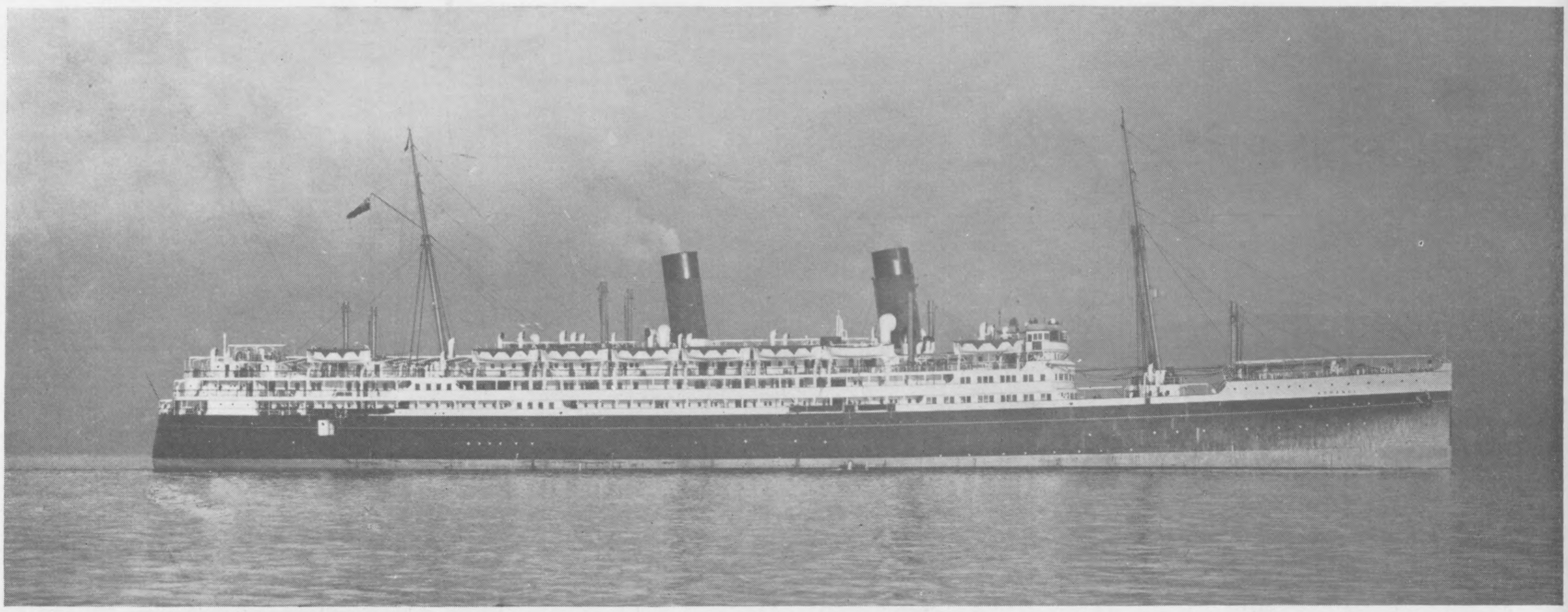
Pilot house control will be arranged for on the Ward-Leonard system. The drive to the sternwheel will be by means of a silent chain, with a reduction in speed of 4.67 to 1. The sternwheel is to be 11 ft. 4 in. in diameter by 11 ft. wide.

An auxiliary air compressor will be provided, capable of compressing 10 cu. ft. of free air per min. to 1000 lb. pressure; it will be driven by a 115 volt d.c. motor mounted on the same bedplate. The auxiliary generating set will be an oil engine direct connected to a 7½ k.w. 120 volt d.c. generator.

	Charles Ward Engineering Works, Charleston, W. Va.	Dravo Contracting Co., Pittsburgh, Pa.	Nashville Bridge Co., Nashville, Tenn.	Howard Ship Yards and Dock Co., Madison, Ind.
Delivery of first boat	270 days	240 days	270 days	270 days
Delivery of second boat	300 days	270 days	330 days	300 days
Price	$140,900.00	$156,400.00	$127,480.00	$146,437.00

New Light Vessel Has Diesel Engine

Among its newer light vessels the Bureau of Lighthouses will have one equipped with a Diesel engine for propulsion. This will be Light Vessel "No. 111," of the same type and class as the new lightship on Nantucket Shoals, regarded as the most important lightship station in the world. A vessel of about 775 tons displacement, "No. 111" measures 132 ft. 4 in. in length overall, 30 ft. in breadth and 16 ft. in depth. She will thus assume the distinction of being the largest motor lightship yet commissioned or projected by any country. Her engine will be an 8-cylinder 500 s.h.p. Winton engine, taken over from the War Department, which originally installed this set in one of the River type concrete boats. This light vessel will probably be assigned to Northeast End light vessel Station, N. J. As a commentary on the lesser known risks of the Lighthouse Service, it may be remarked that the hull of the new motor lightship was built at the expense of a big oil company to replace a light vessel sunk by one of the company's barges. The motor lightship will be ready next summer the installation of the varied equipment being now under way.



The largest Diesel-driven passenger liner afloat. The Sulzer-engined quadruple screw ship AORANGI

Big Pacific Passenger-Liner on Maiden Voyage

"Aorangi," a Diesel-Driven Ship of 23,000 Tons Displacement and 14,600 Total s.h.p. Makes Good Speed Across the Atlantic

JUST over two years ago the Union Steamship Company of New Zealand startled the shipping world by ordering a huge motor-liner for its transpacific passenger service. Today this big Diesel-driven craft—the AORANGI—is on her maiden voyage of about 16,000 miles at 18 knots speed. Surely a terrific test for any vessel, let alone a ship driven by the highest powered machinery yet in commercial operation of a type almost unknown in marine work fifteen years ago. Swift is the progress of modern engineering when properly encouraged and nourished.

The AORANGI crossed the Atlantic and arrived at Kingston, Jamaica, on Jan. 14, having sailed from England on Jan. 2.

We are advised by special cable from Kingston that the vessel averaged 17 knots on a fuel-consumption under 56 tons per day, inclusive of all auxiliaries. Her Diesel engines worked very satisfactorily throughout at 120 r.p.m. without any stoppage. A cable from the AORANGI to Norton, Lilly & Co., New York, stated that despite leaving England 17 hours late she arrived at Jamaica on schedule, although a bad spell of weather was met en route.

She has proceeded for Los Angeles via the Panama Canal, whence she goes to Vancouver to inaugurate her regular service to Australia and New Zealand via Honolulu and the Fiji Islands. While during this year she will be eclipsed in power and tonnage by six double-acting Diesel-driven ships now building, she at present holds the blue ribbon, being the most important motorship in service.

On the occasion of the AORANGI'S launch last year a complete description of her was published in MOTORSHIP, and this is to be found in our issue of August last, so a description of her luxurious accommodation will not be repeated at this time. Certain minor modifications have been made regarding some of the preliminary figures and these we now give in their latest form.

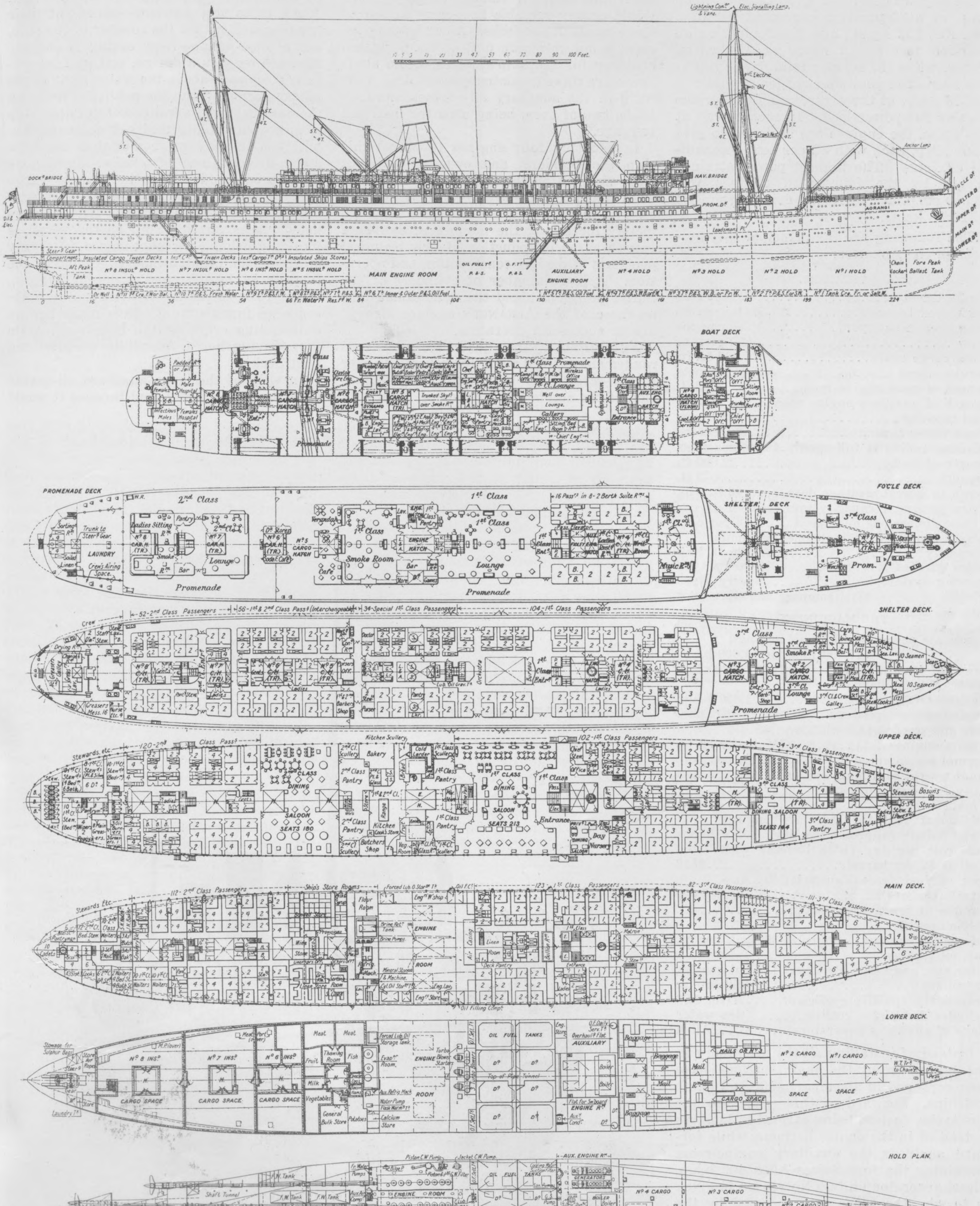
The AORANGI incorporates the very latest practice in passenger-liner construction, and is a quadruple-screw ship of 23,000 tons displacement, 17,500 tons gross, with accommodation for 1,000 passengers and a crew of 330 officers, engineers, stewards, stewardesses, etc., and men. Built at the Fairfield shipyard on the Clyde, she is propelled by four Sulzer-type two-cycle Diesel engines of 3,250 s.h.p. with six single-acting cylinders 27½ in. bore by 39 in. piston stroke, turning at 127 r.p.m. or with a piston speed of 825 r.p.m. They were constructed by the builders of the hull. Together with four Swiss-built Sulzer 400 b.h.p. auxiliary Diesel engines in a separate engine-room, the ship has a total power of 14,600 shaft h.p., several hundred horsepower of which is stand-by power. There are two auxiliary boilers in addition for the deck machinery, heating the ship and for sundry auxiliary equipment.

Mr. Charles Holdsworth, Chairman of the Union S. S. Co., owners of the AORANGI, with Mrs. Holdsworth and Sir Alex. M. Kennedy, Chairman of the company which built the vessel

Her sea trials lasted for over a week, covering 1,600 nautical miles, and included a 60 hours non-stop run, during which heavy weather was met. For this trip the engines averaged 15,300 i.h.p., or approximately 12,200 shaft h.p. at 123 r.p.m., the ship's speed being 17.91 knots, or only a trifle under her designed maximum speed. The main engine fuel consumption is reported as figuring out at 0.395 lb. per shaft h.p. hour. This gives a consumption at this load of 48 tons per 24 hour day, assuming that the shaft power reading was carefully taken by a torsion meter.

Neither the exact consumption in tons of the auxiliary engines, nor the power averaged, nor the number of 400 b.h.p. units run has been given, but the auxiliary consumption is stated to have been 0.036 lb. per s.h.p. of the main engine. However, to obtain accurate consumption per s.h.p. hour, the actual power developed by the auxiliaries and applied to operation of the main engines must be segregated from the auxiliary power applied to the ship's service. This does not appear to have been done, and we cannot make a check, as the builders have not released the total consumption averages per 24 hours. As near as we can figure from the data given, the total consumption with auxiliary engines was about 53 tons, meaning that the auxiliary units ex-donkey boilers were burning about 5 tons per day. This, however, is not certain, though it seems to be confirmed by our report from Jamaica given above.

Over the measured mile the power developed by the main engines was 15,000 i.h.p., or approximately 12,400 s.h.p., driving the ship at 18.237 knots. Absence of tremor and vibration, even at the stern, was noticeable, and in the stern accommodation it was difficult to tell whether or not the engines were running. On shop trials one of



Courtesy of Marine Engineer & Motorship Builder.

Profile and accommodation plans of the transpacific motor-liner AORANGI

these engines developed 4,750 i.h.p. or 3,800 s.h.p. on a 20 per cent overspeed run of 2 hours at 152 r.p.m., and 3,552 s.h.p. on an overload test of 12 hours at 131 r.p.m. Hence, while the regular total power is 13,000 s.h.p., the possible emergency power is 14,208 s.h.p. at three revolutions above the regular full-power load. In fact, if run at 135 r.p.m. the engines are designed to give 3,500 s.h.p. each with 82 per cent mechanical efficiency. The highest power attained at sea by the four main engines was 13,650 s.h.p. at 128 r.p.m., driving the ship at 18:58 knots.

The following are the principal specifications of the AORANGI:

THE HULL

Displacement	23,000 tons
Registered tonnage	17,500 tons gross
Passenger capacity	1,000 persons
Crew	330 persons
Total cargo space	315,000 cu. ft.
Service speed	17 to 18 knots
Length of main engine room	72 ft.
Length of auxiliary engine room	50 ft.
Fuel capacity	3,000 tons
Fresh water capacity	1,000 tons
Cruising radius at full speed	16,000 sea miles
Length of hull	600 ft.
Breadth	72 ft.
Depth to lowest weather deck	46 ft. 6 in.
Extra passenger capacity over steamer of same dimensions and speed	18 per cent
Length compared with steamer of similar capacity	25 ft. less
Cargo winches	16 steam type
Steering system	Sperry Gyro compass and Gyro pilot

THE MACHINERY

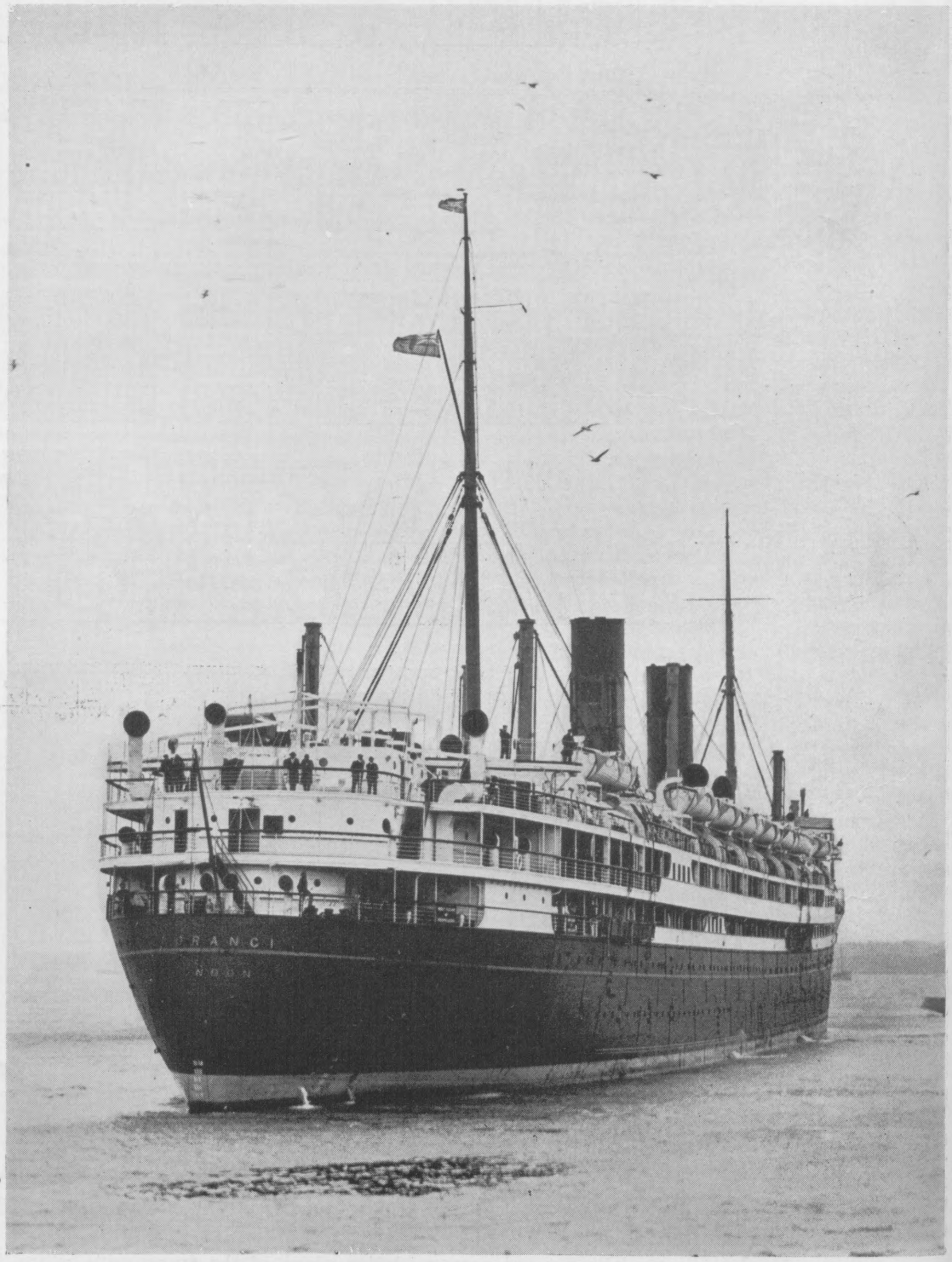
Aggregate power of all Diesel engines,	17,000 i.h.p. or 14,600 b.h.p.
Power of 4 main engines (total)	13,000 s.h.p.
Power of 4 auxiliary engines (Sulzer built)	1,600 b.h.p.
Engine service speed	127 r.p.m.
Bore and stroke of main engines	27½ in. by 39 in.
Normal piston speed	825 ft. per min.
Total weight of 4 main engines	1,180 tons
Daily fuel consumption of main engines	48 tons
Additional fuel for auxiliary engines and boilers (approx.) per day	10 tons
Fuel cost per day (with boilers) with oil at $2 per barrel	$812
Cost of fuel from Vancouver to Australia (about)	$15,000
Number of firemen carried	2
Lub.-oil purifier for main engines	Sharples 300-gal. per hr.
Lub.-oil purifier for aux. engines	De Laval 110-gal. per hr.
Propellers	4 solid bronze
Propeller propulsive coefficient	Over 0.58
Cylinder and piston cooling	Sea water
Make of auxiliary generators	Allen

Instead of installing all the machinery in one engine-room, the main engines have been arranged in a compartment just abaft midships. Forward of this space are the fuel tanks, fuel-oil being carried in bunkers instead of in the double bottoms, while forward again is the auxiliary engine-room containing the four Sulzer-Allen 400 b.h.p. Diesel-generator units. No reason is given as to why the space now occupied by the fuel tanks is used for fuel-oil and why no use is made of the double bottoms for this purpose, but presumably it is because no passenger accommodation is below the main deck and if the present auxiliary engine-room space was used for cargo it would be difficult for access unless a hatch were built abaft the forward funnel, which in turn would occupy valuable first-class passenger space on about six decks. Abaft the engine-room below the main deck is the insulated chamber for the ship's stores, while abaft again are three insulated cargo holds. Forward of the auxiliary oil-engines are four holds, two of them being used for mail and baggage.

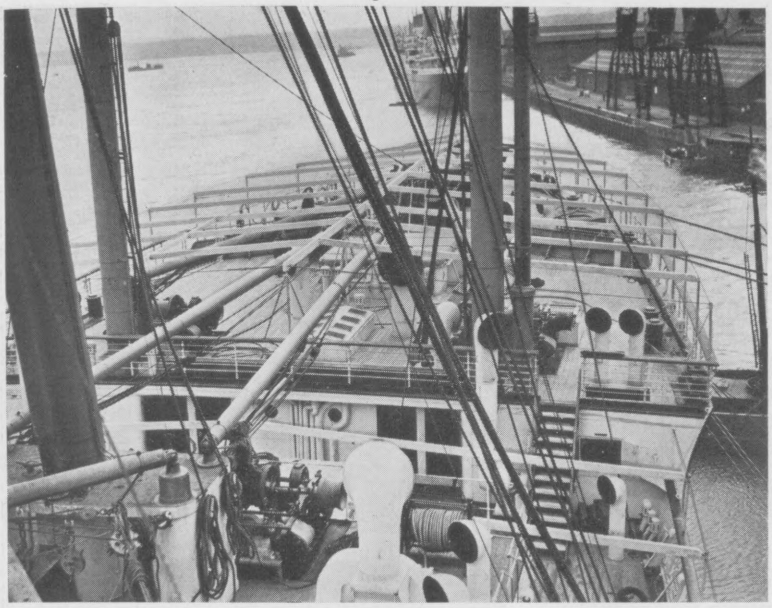
In adopting four engines to propel this ship the builders' and owners' decisions were weighed by the fact that the cylinder sizes would not have to go beyond those of engines actually in service and that by merely increasing the number of cylinders there was no introduction of new technical problems of design, construction and operation. A large number of cylinders of the Sulzer design of about the same dimensions as those of the AORANGI'S engines already are in successful operation.

Furthermore, the quadruple-screw arrangement enabled many improvements over a twin-screw liner as regards the distribution of the accommodation space. Not only do the "small" propellers—which have been found to be very efficient—permit of their housing well within the counter of the ship, but a large engine-room casing is entirely obviated by such a design, setting free considerable space above the water line for the purpose of enlarging the public rooms. With the well-balanced arrangement of this ship it is not surprising that her passenger capacity is 18 per cent greater than that of a steam-driven liner of similar dimensions and speed, aside from her ample cargo carrying capacity. In one sense it seems a pity that the owners conservatively have fitted stacks on this ship as the vessel is indistinguishable in appearance from any steam-driven craft, although, of course, the two stacks have served a useful purpose, namely, for the exhaust, silencers, etc. Absence of funnels would have made her an outstanding craft on the high seas, aside from giving her a splendidly unobstructed boat deck.

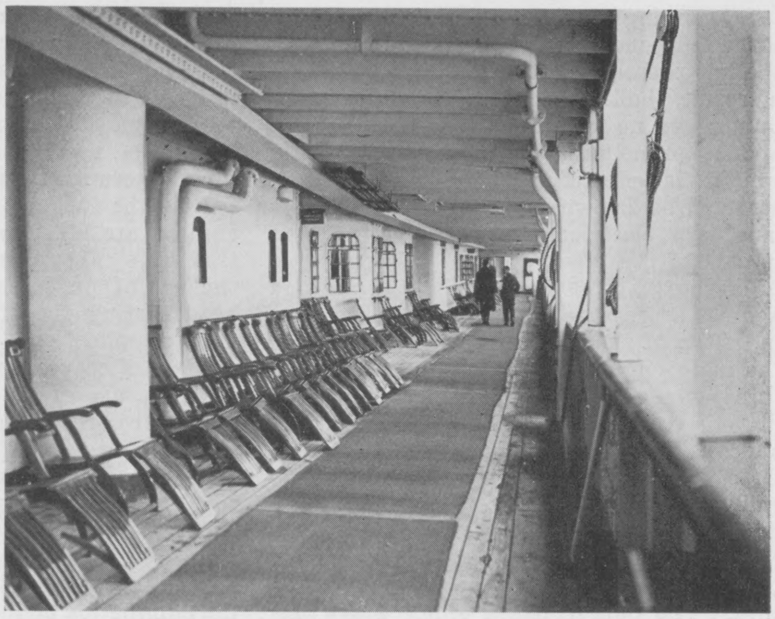
In view of the large auxiliary oil-engine capacity of the vessel, and because it would



Motor-liner AORANGI leaving Southampton outward bound for her 16,000-mile maiden voyage, a record trip for a new motor-vessel



The only mechanism on the AORANGI which is not up-to-date is the steam deck machinery. Some of these winches can be seen in the foreground



An idea of the size of the AORANGI can be obtained from this view of the promenade deck. Her spacious decks are ideal for the morning exercise

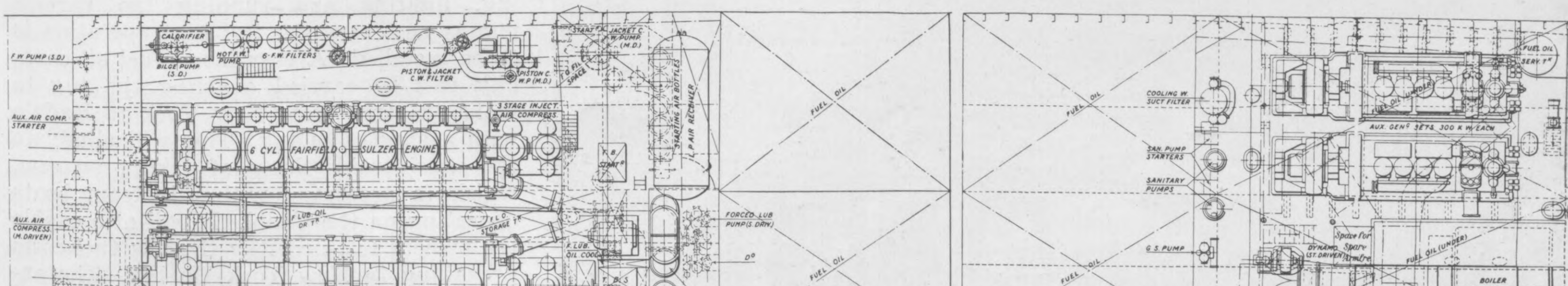
have been a simple matter to have increased this if necessary, it is surprising to find that the owners have adopted steam for the deck winches, particularly as the electric deck-winch has today reached such a high stage of efficiency. We are inclined to think that the accommodation in the neighborhood of the auxiliary boilers will be uncomfortably warm when the vessel is in port, particularly in tropical waters.

In service this vessel will be called upon to render a performance each one-way trip from Vancouver to Sydney, via the intermediate ports, which will be equal to $2\frac{1}{2}$ one-way non-stop runs across the Atlantic; hence it is reasonable to suppose that the owners have the fullest confidence in the complete reliability of Diesel drive even in such high power, and that their views are based partly on the experiences with one large cargo motorship which they have been operating for several years.

If one may judge by the photographic illustrations which are to hand, both the cabin and public room accommodations of this vessel are equivalent in character to the largest and finest transatlantic liners, no effort having been spared to render the furnishings, upholstering and decorations equal to what will be found in the best American hotels. In fact, her first-class public rooms combine the stately dignity of historical period decoration with the comfort and hygienic practices of the present day. And the standard recently set up by high-class liners for luxurious comfort in traveling on deep sea voyages is being more than maintained in this new vessel by the well proportioned and skilfully modelled architectural detail of the rooms. For a more detailed description of the various public rooms we will refer readers to the account given in MOTORSHIP last August.

It may be contended because of the comparatively high cost of Diesel power, which generally speaking, is approximately 30 per cent greater than that of steam machinery, that it will be necessary for great economies to be effected in order to make a return on the initial investment, but we have already pointed out how the passenger capacity is actually 18 times higher than that of a similar steamer. To provide the same accommodation a steamship would have to be about 25 ft. longer and shipbuilders and shipowners in this country in consequence will realize that to have the same earning powers a steam liner may be just as high in first cost. The accommodation of passengers is divided into 440 in the first-class, 330 in the second class, and 230 in the third class.

One advantage of Diesel drive is that a cruising capacity of 16,000 miles on the comparatively small quantity of oil carried, namely, 3,000 tons, is sufficient for the round voyage from Vancouver to Sydney, a distance of approximately 15,000 miles, which will enable her to purchase fuel-oil wherever it can be obtained at the lowest price. No information has been given out as to what fuel-oil is being used on the maiden voyage, but boiler-oil was used on the engine tests in the shops and it is our understanding that this heavy fuel is to be used on her regular run as soon as the engineers are thoroughly familiar with the machinery in their care.



Courtesy of Marine Engineer & Motorship Builder.

Main engine-room and auxiliary engine-room of the AORANGI, showing the double fuel-oil bunkers between

Scavenging air is supplied by means of three independently driven turbo-blowers at the low pressure of 1.75 lb. per sq. in. As a result, bulky reciprocating scavenging pumps are no longer fitted to the engines, and a pronounced saving in space and weight is effected. These blowers, constructed by Brown Boveri, Baden, Switzerland, are electrically driven and are the largest of the type yet built, being capable of discharging 560 cu. ft. of air per second against a pressure of 1.75 to 2.1 lb. per sq. in. Two of the blowers will be used when the main engines are running, leaving the third as a stand-by. They are electrically driven, turning at 2,000 to 2,600 r.p.m., and the motors are wound for 220 volts D.C. The three sets are erected in a specially constructed suction chamber specially designed and insulated by a combination of cork and hard felt—to prevent the noise of the indrawn air being noticeable in the ship. The blower has a single stage impeller overhung on the common motor and blower shaft. The spiral casing is bolted to the bedplate, the air inlet being conical and arranged axially and the outlet tangential and pointing downwards. Special diffuser vanes are provided for control of the pressure-volume characteristic.

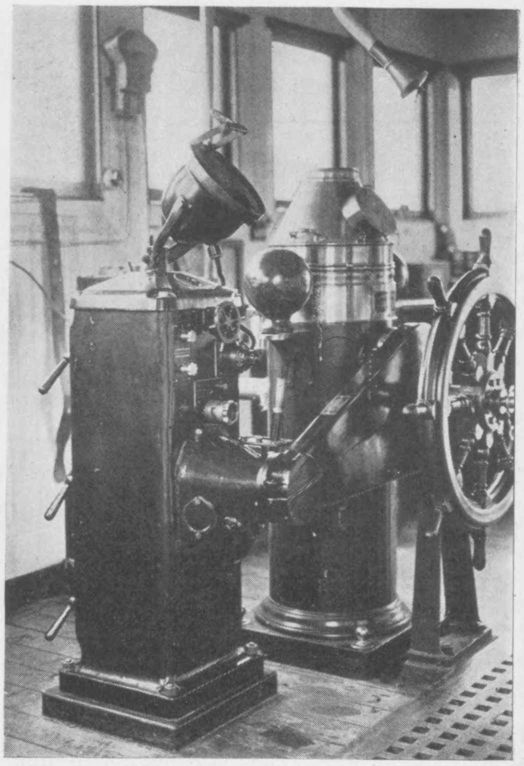
Exhaust gases do not seem to be made full use of but evidently it is intended to use some of the heat, and with this object a special cast-iron fresh-water heater for ship's service is fitted around two of the inboard exhaust pipes and also asists in cooling the gases before they enter the silencer.

As regards the four main 3250 s.h.p. Diesel engines and the four auxiliary Diesel engines they depart in but few details from the well-known characteristics of the Sulzer design of machinery. Attention is called in passing to the fact that Sulzers have retained the box-frame construction for crosshead engines of larger capacity than any manufactured by other firms. As the result of this practice great stiffness is imparted to the entire structure, a consideration of prime importance for the maintenance of alignment of all working parts irrespective of engine loading or ship's deflections. The box-frame also lends itself well to the adaptation of the four-shoe crosshead, the guides for which are mounted directly on the transverse webs that partition off the individual crank chambers.

Both the fuel and starting valves of these engines are accommodated in a single central valve cage, a procedure which permits the use of an essentially conical cylinder-head casting free from the usual pockets and complications. The present Sulzer method of scavenging has been adhered to, with the use of automatic plate valves for the control of the upper row of scavenging ports. Since they lift and allow the scavenging process to commence promptly as soon as the exhaust pressure in the cylinder permits it, they make available a greater time-area opening than is the case with mechanically-operated valves. Obviously, also, the elimination of the driving and reversing gear necessary for the latter mechanisms is a great advantage and leaves only one valve—the one for fuel injection—to be operated while the engine is running.

As the main engines are of the air-injection type there is driven off the forward end of each two 3-stage air-compressors, either of which has sufficient capacity to supply the fuel-injection air for one main engine when at full power.

The double bottom of the ship in way of the main propelling machinery is made specially deep, and particular attention has been paid to the design of the girder work in the double-bottom tank so as to distribute the load and the stresses arising from the propelling machinery. The soleplate and columns are also strengthened to prevent possible vibration, and the bearing surfaces are increased so as to reduce the working pressures on these parts. The crankshaft is 19 in. in diameter, which provides an ample margin above the requirements of Lloyd's Register. It is of semi-built type, the crankpin and its webs being forged in one piece with the main journals shrunk in. Two large dowel pins, eased away in a radial direction to insure the shrink grip being maintained, are fitted between each web and its journal pin.



Steering on the AORANGI is carried out by the Sperry gyro-pilot and Sperry gyro-compass. When on the open seas there is no need to have a man at the wheel, steering being automatic once the course is set

A corner of the first class dining room of the AORANGI

Steam Tug to Be Converted

With the order for the conversion of the steam towboat JAMES M. BROOKS to Diesel power, the motor-tug fleet on the New York State Barge Canal will receive the addition of another unit. This boat, built in 1920, measures 77 ft. overall with 20 ft. beam. Louis O'Donnell of New York, the owner of the tug, recently placed the order for the 300 s.h.p. engine for this installation. The engine, which will be a six-cylinder Nelseco, will be direct connected to the propeller. Auxiliary equipment for heating, lighting and running the various pumps necessary for tug boat operation is to be installed. A very large fuel oil capacity will be carried enabling the tug to make the trip from New York to Buffalo with a single fuelling. This will eliminate the considerable delay of taking on coal, which is necessary with all steam boats operating on the Canal. It will also enable the owners to benefit by the low fuel costs prevailing in New York Harbor. The engine and boiler are now being removed at Bushey's Shipyard, Brooklyn, where the fuel tanks, miscellaneous foundations and auxiliary equipment will be installed. The tug will then probably be towed to New London for the installation of the main engine and piping. Delivery of the completed boat will probably occur around May first, in time for the opening of the Barge Canal.

Another Worthington oil-engined stern wheeler has been ordered by the Nashville Bridge Company, Nashville, Tenn. She will be 131 ft. long, and will have a 200 b.h.p engine driving twin wheels by means of gearing and silent chains.

Proposed Shipping Act of 1925

Tax Exemption Clause in Bill No. S-3836 for American Companies Converting Steamers to Diesel Power

SENATOR WESLEY L. JONES at Washington, known for his sound marine legislation and for the great interest which he takes in our country's maritime affairs, introduced to Congress on Jan. 5, 1925, Bill S-3836 to amend the supplement to the Merchant Marine Act of 1920 and which will be known as the Shipping Act of 1925 if made law.

One of the main features of this bill is to transfer the powers of fleet operation entirely to the Emergency Fleet Corporation, which hereafter will be known as the United States Fleet Corporation. Of direct interest to readers of this magazine is Section 8 of the new Bill, which is to amend Section 23 as follows (the italics are ours):

"Section 23. To encourage the construction of vessels in shipyards of the United States and their maintenance and operation under the American flag, it is hereby enacted:

"(a) That the owner of a vessel documented under the laws of the United States and operated in foreign trade shall, for each of ten taxable years while so operated, beginning with the first taxable year ending after June 5, 1920, be allowed as a deduction for the purpose of ascertaining his net income subject to the war profits and excess profits taxes imposed by Title III of the Revenue Act of 1918, or any and all taxes on income imposed by the Revenue Act of 1921, or by any subsequent revenue act, an amount equivalent to the net earnings of such vessel during such taxable year, determined in accordance with rules and regulations to be made by the board; Provided, that such *owner shall not be entitled* to such deduction *unless*, within a time to be fixed, and under rules and regulations to be made by the board, *he has invested or has set aside in a trust fund for investment*, either (1) in the building, in shipyards in the United States, of a new vessel or vessels to be of the type and kind approved by the board, or (2) *in the purchase and installation* in the United States, *including installations in an American vessel already built, of internal combustion marine engines,* built in the United States, *as the main propulsive power of the vessel,* including work and equipment incident to such engines, an amount to be determined by the Secretary of the Treasury and certified by him to the board equivalent to the war profits and excess profits taxes imposed by Title III of the Revenue Act of 1918, and taxes on income imposed by the Revenue Act of 1921 or by any subsequent revenue act of the United States, that would have been payable by such owner on account of the net earnings of such vessel, but for the deduction allowed under the provisions of this section; Provided, however, that at least two-thirds of the cost of any vessel or two-thirds of the cost of the internal-combustion engine and of its installation, shall be paid for out of the ordinary funds or capital of such owner.

"(b) That during the period of ten years from the original enactment of the Merchant Marine Act, 1920 (June 5, 1920) *any person a citizen of the United States, who may sell a vessel* documented under the laws of the United States and built prior to Jan. 1, 1914, *shall be exempt from all taxes on income that would be payable upon any of the proceeds of such sale,* imposed by Title I, Title II and Title III of the Revenue Act of 1918, or imposed by the Revenue Act of 1921, or by any subsequent revenue act of the United States, *provided such person,* within a time to be fixed and under rules and regulations to be made by the board, *invests the entire proceeds of the sale,* or sets aside the entire proceeds in a trust fund to be used either (1) in the investment in the building, in shipyards in the United States, of a new vessel or vessels to be of a type and kind approved by the board, or (2) *in the purchase and installation, in the United States, including installation in an American vessel already built, of internal combustion marine engines built in the United States, as the main propulsive power of the vessel,* including equipment incident to such engines.

"(c) In the event a trust fund is set aside, as above provided, interest accumulating thereon shall become a part of the fund, to be invested as above provided, on the same basis as the principal of the amount.

"(d) Any vessel constructed or re-equipped under this paragraph shall not, for a period of ten years from the date it is launched or completed, be documented under the laws or operated under the flag of any country other than the United States, without the consent of the Shipping Board as now provided by law. On the completion of the new vessel it shall be documented under the laws of the United States, and such new vessel, or, as the case may be, the vessel equipped with internal combustion engines, as above provided, shall be kept documented under the laws of the United States to a date not less than ten years from the date the new vessel was launched, or, as the case may be, from the date the old vessel thus re-equipped with internal combustion engines reenters commercial service after the installation of such engines. The acceptance by an owner either of the deduction or exemption provided for by this section shall be an acceptance by him of the obligation hereby imposed relative to documentation of the vessel, and such obligation shall be a covenant running with the ship, binding alike on the owner and all subsequent owners or other persons interested. An indorsement, in form prescribed by the board, may be made on the ship's papers that the vessel is subject to this provision of law and such indorsement shall be notice to all persons having or thereafter acquiring an interest in the vessel. The vessel is hereby charged with a lien for the principal of the amount of the taxes the owner has saved under the provisions of this section, which lien shall continue for a period of ten years, through which it must be kept documented under the American flag, provided an indorsement is made on the ship's papers, as above authorized; and in the event the covenant is violated, there shall be payable to the United States the amount thereof, and it shall be the duty of the Attorney General of the United States to enforce this obligation.

"(e) In the event any vessel constructed under this paragraph is lost or destroyed, including constructive total loss, at any time within ten years from the date it is launched, there shall be paid to the United States from the proceeds of any insurance on the hull, as many one-tenth parts of such proceeds as years remain of the period through which it is to be kept documented under the laws of the United States."

The foregoing clauses together with the recent amendment to Sections 11 and 12 which are already law should do much to assist American shipowners, and at the same time produce a merchant marine of the most modern, the most efficient and the most economical type. The bill seems to be receiving general approval in Congress, and with minor modifications is likely to be passed at an early date when it will go to President Coolidge for signature.

Another W. D. Pipeline Dredge Planned

Bids will shortly be called by the District Engineer Office of the U. S. War Department at Philadelphia, for a 20-in. Diesel-electric driven hydraulic pipeline dredge. This will make six large Diesel-driven dredges ordered by the War Department, four being the Diesel-electric hopper dredges now in service, and the fifth a pipeline dredge nearing completion at the Chas. Ward Engineering Works, Charleston, W. Va.

The approximate dimensions of the new vessel are as follows—

Length, md.	170 ft.
Breadth	40 ft.
Depth	13 ft.
Total power	2,620 b.h.p.

The machinery will consist of one 1,000 b.h.p. Diesel engine direct connected to the dredge pump, one generating-set driven by a Diesel engine of 750 b.h.p. for driving the booster pump, one 750 b.h.p. Diesel-generator set for driving various auxiliaries and a second auxiliary oil-engined generating set of 120 b.h.p.

A few years ago the oil-engine was comparatively unknown for dredge work. Today dredges of the largest size are being operated by Diesel-electric power. Careful study of the problems by engineers has shown that very important economies can be effected. Not only has the War Department done a considerable amount of important development work in this direction but private owners have also done their share. One large Diesel-electric dredge is that now building at the Newport News Shipbuilding & Dry Dock Co., and another is the big one for the Port of Portland, Ore.

U. S. SHIP CONVERSIONS COMPLETED OR IN HAND

SHIP'S NAME	OWNER OF SHIP	SHIPBUILDERS	YEAR OF CONVERSION	CONVERTED BY	REGISTERED LENGTH	REGISTERED BREADTH	REGISTERED DEPTH	TONS GROSS	TONS D. W.	TYPE OF ENGINE	UNIT NO. OF CYLS.	CYL. DIAM.	STROKE	R.P.M.	NO. OF ENGINES	TOTAL S.H.P.
1. MUNMOTOR	Munson S. S. Co., New York.	Great Lakes Eng. Works	1922	Sun S. B. & D. D. Co.	253.5	43.5	25.5	2,450	4,200	McIntosh & Seymour 4-cyc.	6	22.00	32.00	135	1	925
2. ASHBEE	New York S. B. Co., Philadelphia.	Merrill Stevens S. B. Co.	1923	New York S. B. Co.	333.8	48.0	24.9	3,424	5,500	New York-Werkspoor 4-cyc.	6	27.00	47.00	110	1	1,500
3. BIDWELL	Sun S. B. & D. D. Co., Chester, Pa.	Baltimore D. D. & S. B. Co.	1923	Sun S. B. & D. D. Co.	431.0	59.2	33.3	7,050	10,250	Sun-Doxford 2-cyc.	4	22.83	91.34	72	1	2,500
4. FRANK LYNCH	W. J. Gray, Jr., San Francisco	Toledo S. B. Co.	1923	Union Construc. Co.	252.0	43.5	18.9	1,893	3,000	Pacific-Werkspoor 4-cyc.	6	20.47	35.43	135	2	1,500
5. MILLER COUNTY	Sun S. B. & D. D. Co., Chester, Pa.	Baltimore D. D. & S. B. Co.	1923	Sun S. B. & D. D. Co.	431.0	59.2	33.3	7,050	10,250	Sun-Doxford 2-cyc.	4	22.83	91.34	72	1	2,500
6. MUNCOVE	Munson S. S. Line, New York.	Great Lakes Eng. Works.	1923	Sun S. B. & D. D. Co.	253.4	43.7	24.5	2,450	4,125	McIntosh & Seymour 4-cyc.	6	22.00	32.00	135	1	925
7. SEEKONK	Wm. Cramp & Sons S. B. & E. Co., Phila.	Amer. International S. B. Co.	1923	Wm. Cramp & Sons S. B. & E. Co.	390.0	54.2	27.6	4,998	7,500	Cramp-B. & W. 4-cyc.	6	29.13	59.00	90	1	1,770
8. CARISSO	Oceanic S. S. Co., San Francisco.	Long Beach S. B. Co.	1924	Moore S. B. Co.	341.0	48.0	27.2	3,899	5,900	Pacific-Werkspoor . . 4-cyc.	6	20.47	35.43	135	2	1,500
9. CHALLENGER	Sun S. B. & D. D. Co., Chester, Pa.	Bethlehem S. B. Co.	1924	Sun. S. B. & D. D. Co.	410.0	56.0	38.0	7,590	11,850	Sun-Doxford 2-cyc.	4	22.83	91.34	72	1	2,500
10. J. W. VAN DYKE	Atlantic Refining Co., Philadelphia.	Pusey & Jones Co.	1925	Staten Island S. B. Co.	364.9	51.0	29.5	4,908	....	Ingersoll-Rand 4-cyc.	6	19.50	24.00	225	3	....†
11. JACKSONVILLE	New York S. B. Co., Philadelphia.	Merrill Stevens S. B. Co.	1925	New York S. B. Co.	333.5	48.0	24.9	3,513*	....	New York-Werkspoor 4-cyc.	6	27.00	47.00	110	1	1,500
12. LIO	General Petroleum Co., Los Angeles.	Baltimore D. D. & S. B. Co.	1925	Bethlehem S. B. Corp.	431.0	59.2	31.4	7,245*	....	Bethlehem 2-cyc.	6	27.00	60.00	85	1	2,800
13.	U. S. Shipping Board.	....	....	....	....	...	...	....	....	McIntosh & Seymour 4-cyc. d. a.	4	32.00	52.00	95	1	2,700
14.	U. S. Shipping Board.	....	....	....	....	...	...	....	....	New London 2-cyc. d. a.	4	27.55	43.30	95	1	3,000
15.	U. S. Shipping Board.	....	....	....	....	...	...	....	....	Hamilton-M. A. N. 2-cyc. d. a.	4	27.55	43.30	95	1	3,050
16.	U. S. Shipping Board.	....	....	....	....	...	...	....	....	Worthington 2-cyc. d. a.	4	28.00	40.00	95	1	2,900
17.	U. S. Shipping Board.	....	....	....	....	...	...	....	....	Worthington 2-cyc. d. a.	4	28.00	40.00	95	1	2,900
18.	U. S. Shipping Board.	....	....	....	....	...	...	....	....	Cramp-B. & W. 4-cyc.	8	29.13	59.00	90	1	2,800
19.	U. S. Shipping Board.	....	....	....	....	...	...	....	....	Cramp-B. & W. 4-cyc.	8	29.13	59.00	90	1	2,800
20.	U. S. Shipping Board.	....	....	....	....	...	...	....	....	Cramp-B. & W. 4-cyc.	8	29.13	59.00	90	1	2,800
21.	U. S. Shipping Board.	....	....	....	....	...	...	....	....	Cramp-B. & W. 4-cyc.	8	29.13	59.00	90	1	2,800
22.	U. S. Shipping Board.	....	....	....	....	...	...	....	....	McIntosh & Seymour 4-cyc.	6	32.00	60.00	95	1	2,700
23.	U. S. Shipping Board.	....	....	....	....	...	...	....	....	McIntosh & Seymour 4-cyc.	6	32.00	60.00	95	1	2,700
24.	U. S. Shipping Board.	....	....	....	....	...	...	....	....	McIntosh & Seymour 4-cyc.	6	32.00	60.00	95	1	2,700
25.	U. S. Shipping Board.	....	....	....	....	...	...	....	....	Pacific-Werkspoor 4-cyc.	8	31.50	51.19	95	1	2,900
26.	U. S. Shipping Board.	....	....	....	....	...	...	....	....	Pacific-Werkspoor 4-cyc.	8	31.50	51.19	95	1	2,900
27.	U. S. Shipping Board.	....	....	....	....	...	...	....	....	Busch-Sulzer 2-cyc.	6	30.00	52.00	90	1	3,000
28.	U. S. Shipping Board.	....	....	....	....	...	...	....	....	Busch-Sulzer 2-cyc.	6	30.00	52.00	90	1	3,000
29.	U. S. Shipping Board.	....	....	....	....	...	...	....	....	Busch-Sulzer 2-cyc.	6	30.00	52.00	90	1	3,000
30.	U. S. Shipping Board.	....	....	....	....	...	...	....	....	Busch-Sulzer 2-cyc.	6	30.00	52.00	90	1	3,000
31. J. A. MOFFETT, JR.	Standard Oil Co. (N.J.) New York.	Federal S. B. Co.	....	Tietjen & Lang D. D. Co.	499.2	68.1	30.5	9,564*	15,292*	Hamilton-M. A. N. 2-cyc.	4	25.59	47.25	90	2	3,000
32. E. T. BEDFORD	Standard Oil Co. (N.J.) New York.	Federal S. B. Co.	....	Federal S. B. Co.	499.2	68.1	30.5	9,564*	15,319*	Busch-Sulzer 2-cyc.	4	30.00	42.00	90	2	3,000

† Diesel electric drive; total power of main engines is 2520 b.h.p.

*Steamer measurement.

U. S. Steamer Conversions Reach Big Volume

Nearly Quarter Million Tons Gross Changed or Changing to Diesel Power. Aggregate of 80,000 s.h.p.

SHIPBUILDING returns that show only the amount of new tonnage launched or under construction are becoming less and less useful as a criterion of American motorship activities. Their failure to take into account the volume of steamer conversions minimizes the progress which this country is making in the upbuilding of a motorship fleet.

A compilation of the vessels already converted and of those designated for conversion demonstrates that the tonnage involved mounts to nearly a quarter of a million tons gross. It is a very striking total, and drives home in a very forceful manner the important influence of the Diesel engine on American shipyard work at the present day.

Of course, the aggregate tonnage must be viewed within its proper limitations. The table does not represent new tonnage, neither does it indicate merely work in hand, nor does it relate to the accomplishments of a single year. It combines the figures of several years, includes converted vessels in service as well as those which are under contract for conversion, and presents therefore a picture of steamer conversions in the United States as a separate and distinct activity.

Though there is a gap in the ship data between lines 13 and 30 in the table, where the names of the vessels to be converted for the Shipping Board are lacking, this detracts little from the general usefulness of the compilation and does not in any way vitiate the conclusions to be drawn. It is known that these vessels will be either of 8800 tons gross or of 9400 tons gross, and in assuming them to average 9000 tons gross one can make no serious error in computing the aggregate tonnage covered by the table as 230,000 tons gross.

Prior to this year there were only nine ships converted, spread unequally over the years 1922, 1923 and 1924. For completion this year or in the early part of 1926 there are 22 ships in the list. In itself this will give to American shipyards a volume of work that will help the shipbuilding industry very materially to tide over the lean period through which it is passing for lack of new steamship orders.

Of greater industrial importance is the work which these conversions have distributed among the engine builders. There is a total of 80,000 s.h.p. represented by the figures, to which must be added the power of the auxiliary engines provided for these vessels. This branch of the industry could not have benefited more had there been orders for 32 new vessels instead of for 32 conversions.

In looking over the list of owners one observes that the larger number of the early conversions were carried out by shipyards for their own account. These vessels are all chartered today and just as effective a part of the American merchant marine as if they were documented in the name of any of the American lines. The Shipping Board took up the lead shown by the shipyards and is today fostering this movement on a big scale. The oil companies now appear in the list, four vessels standing in the names of large oil corporations. The most recent addition is that of the Standard Oil Co. (N. J.), which has just contracted for the conversion of two of the newest and best built tankers it has under the American flag. Already at an earlier date the same company had ordered the conversion of three tankers operated in foreign trade by subsidiary companies. They are to be converted abroad, and are mentioned here only because they afford additional examples of a new tendency on the part of the greatest and biggest of all the oil companies. The other owners in the list are operating their converted vessels in the coastwise trade, where they will inevitably be joined in due course by others.

Motorization of good steamers of recent build is becoming a marked feature in American shipping and there is a lot of such work understood to be in prospect.

Proposed Marine Fire Hazard Rules

Regulations Drafted for Motorships by National Fire Protection Association Receive Endorsement of the American Bureau of Shipping

WITH such changes as may have shown themselves desirable since the tentative report was issued the Regulations governing Marine Fire Hazards will be adopted at the next annual meeting of the National Fire Protection Association in the spring. It behooves those connected with the construction and operation of motor-vessels and marine oil-engines to study the draft rules and lose no time in making to the Marine Committee of the N. F. P. A. such recommendations as their experiences may suggest.

When these regulations are adopted, their influence will show itself in all marine policies issued by American insurance companies. They will govern also in all surveys made for underwriters. Classification by the American Bureau of Shipping will in itself call for observance of the rules.

Correspondence on this subject should be addressed to S. D. McComb, Chairman of the Marine Committee, 52 Beaver Street, New York City, who in his private capacity is a marine underwriter with the rare combination of shipbuilding experience. Suggestions for the improvement of the code are sure of careful examination, study and possible adoption.

The proposed rules for oil engines follow:

Diesel Engines

(Including Solid Injection Type)

12. FUEL TANKS:

(a) Construction and installation of fuel tanks shall be in accordance with the Regulations Governing Marine Fire Hazards.

(b) Tank filling pipes shall be tight to the deck, with outside connections for filling hose. Connections shall be blanked off when not in use.

(c) The area of the vent shall be so proportioned to the area of the filling line as to permit proper outflow and inflow of air during filling and emptying operations, and no bends except the goose neck shall be closer than 135 deg. inside angle.

(d) The use of gage glasses shall be restricted to service tanks. Such gage glasses shall be suitably guarded and fitted at top and bottom with normally closed spring loaded cocks.

13. PIPING:

Fuel delivery piping on engines shall be of seamless steel and tested to not less than one and one-half times the maximum working pressure. Connections shall be made up with ground joints or on continuous metallic gaskets in counterbores.

14. HEATING COILS:

Where water is used as a heating medium in service tanks, coils shall be easily removable. These coils shall be kept tight to insure against oil leakage into muffler water-heater with possible consequent explosion.

15. PURIFIERS:

Where fuel requiring heating above its flash point is used in centrifugal purifiers, the purifiers and all connections thereto and therefrom shall be absolutely gas tight. It is recommended that the purifier be located in a compartment separate from the engine room. When electric motor driven, motors shall be of gas tight and oil tight construction.

16. EXHAUST:

Exhaust piping shall be run in accordance with Section 4 (c), Appendix D.

Woodwork within 9 inches of exhaust pipe or muffler shall be protected by ¼-in. asbestos board covered with sheet metal, and a clearance of not less than 2 in. shall be maintained between surface of such protection and the pipe or muffler.

17. Boilers:

Donkey boilers or heating boilers shall be installed and operated in accordance with provisions of the Main Rules.

18. Electrical Equipment:

Electrical equipment shall be in accordance with Section 9, Appendix D.

19. Fire Extinguishing Equipment:

Fire extinguishing equipment shall be in accordance with Section 10, Appendix D.

20. Auxiliaries:

Where gasoline engines are used for any auxiliary purposes, they shall be installed and operated in accordance with the provisions of Sections 1 to 11, Appendix D.

21. Operation:

Note: While the fire and explosion hazard of oils such as are generally used on motor vessels are much less than those of gasoline and somewhat less than those of steaming oil, the fact remains that the dangerous atmospheric saturation point of 1¼ per cent may obtain through careless handling of even high flash oil and the hazard of carrying a liquid fuel readily flammable under application of fire is always present.

For these reasons the same precautions as for gasoline shall be observed against leakage into closed or partially closed compartments.

(a) Cleanliness and absence of inflammable refuse, shall be required.

(b) Adequate ventilation of the engine compartment shall receive attention.

(c) Use of naked lights in bilges and poorly ventilated portions of machinery or tank spaces shall be prohibited.

(d) The rules of Appendix A shall be observed in entering fuel oil tanks for any purpose.

Surface Ignition Engines
(Semi-Diesel or Hot Bulb)

22. Fuel Tanks:

(a) Construction and installation of fuel tanks shall be in accordance with the Regulations Governing Marine Fire Hazards.

(b) Tanks shall have drip pans under any draw-off connections.

(c) Tank filling pipes shall be secured tight to deck, with outside connections.

(d) Vents shall be in accordance with Section 12 (c), Appendix D.

23. Piping:

Fuel piping shall be seamless drawn steel tubing and tested to not less than one and one-half times the maximum working pressure. Connections shall be made up with ground joints or on continuous metallic gaskets in counterbores.

24. Starting Torches:

Wood work within three feet of starting torches shall be sheathed with ¼-in. asbestos board secured by sheet metal.

25. Exhaust:

Exhaust piping shall be run in accordance with Section 4 (c), Appendix D.

Woodwork within 9 inches of exhaust pipe or muffler shall be protected by ¼-in. asbestos board covered with sheet metal and a clearance of not less than 2 inches shall be maintained between surface of such protection and the pipes or muffler.

26. Bilges:

In order to keep the bilges free from floating oil a fixed hand bilge pump (preferably of turbo type) with not less than one inch discharge shall be provided in engine room in addition to any power bilge pump.

27. Ventilation:

Engine room ventilation should be generally in accordance with Section 5, Appendix D.

28. Fire Extinguishing Equipment:

Fire extinguishing equipment shall be in accordance with Section 10, Appendix D.

29. Electrical Equipment:

Electrical equipment shall be in accordance with Section 9, Appendix D.

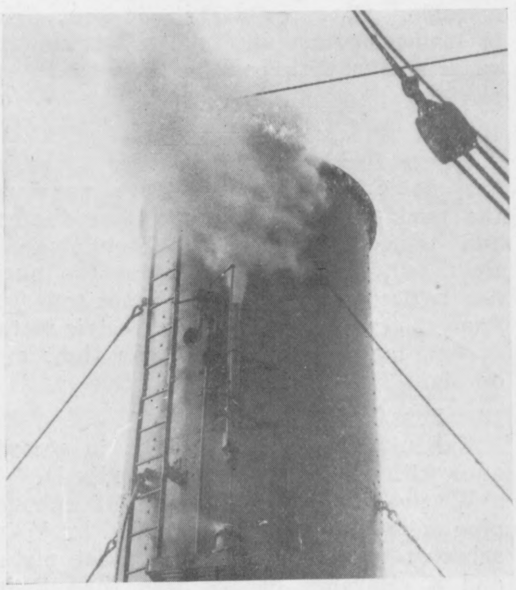
30. Operation:

Operation shall be in accordance with Section 21, Appendix D.

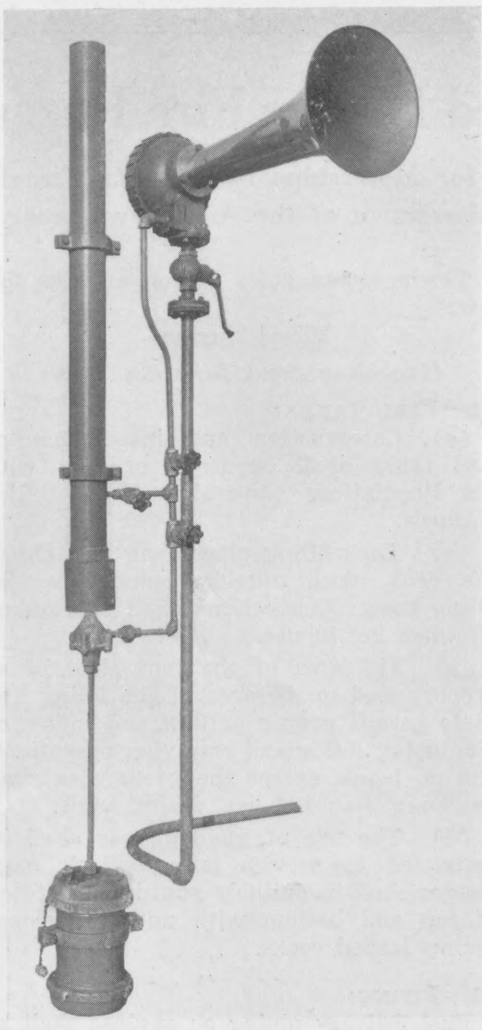
A Visible Air Whistle for Motorships

An objection which has been urged against complete electrical auxiliaries in motorships is the fact that when there is no steam on board the whistle has to be operated by compressed air or electricity. This means that with the ordinary type of whistle there is no "feather" to indicate to approaching ships where the sound comes from. In a crowded waterway there are occasions when this may be distinctly awkward, as a pilot may be unable to identify which of several vessels is signalling, and a good deal of confusion may result.

To overcome this difficulty the Sperry Gyroscope Company has developed a visible air whistle, which, while operating on compressed air, gives at the same time a cloud of white smoke which can be readily seen by an approaching ship.



Air whistle shows white feather as good as any on steam whistle



Smoke liquid tank, smoke pipe and horn of Sperry Visible Air Whistle

The method by which this is effected would appear to be analagous to the way in which smoke screens are emitted from military airplanes. With the opening of the whistle valve, air is admitted to a nozzle which then takes a certain amount of "smoke liquid" from a tank, atomizes it and forces it through a pipe from which it issues in a dense white cloud. When it is desired to use the whistle as a fog signal only, the smoke producing element can be shut off by a valve which is provided for the purpose.

Korsholm, a 5000 tons d.w. motorship, has been launched at the Götaverken to the order of the Swedish America Line. Götaverken-B.&W. Diesel engines of 2000 s.h.p. at 100 r.p.m. provide propelling power. This engine is equipped with a supercharger.

Passage of the bill appropriating $90,000 for an experimental oil shale plant on Naval Reserve No. 2 in Colo. is now virtually assured. Credit is due Sen. Lawrence C. Phipps, of Colo. The two reserves in Colo. are estimated to yield two and a half million barrels of crude oil.

Having exceeded her contract speed on her trials, the North German Lloyd Motorship Fulda is now on her maiden voyage. She is of 9450 tons gross and is propelled by two Sulzer Diesel engines of 3500 i.h.p. each. The vessel has been placed in the Far East service via the Suez Canal.

Diesel Electric Drive for Harbor Towboats

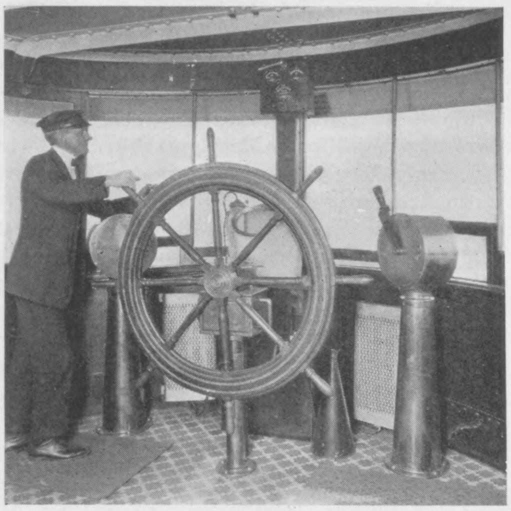
Operators of the "P. R. R. No. 16" Give First Hand Opinions Based Upon Their Experiences

HOW the tendency of our railroads leans strongly toward modernizing their floating equipment, in the same manner as is done with their rolling stock on land, was recently demonstrated by F. L. DuBosque, Superintendent of the Pennsylvania Railroad's floating equipment, in a paper before the Society of Naval Architects dealing with his company's Diesel-electric driven tug P.R.R. NO. 16. More on this important subject was outlined at a meeting on Jan. 6 at the Pennsylvania Railroad Y. M. C. A. in Jersey City, N. J. The vast number of tugs in New York harbor and district, particularly in the service of the railroads, produce many varying problems needing exhaustive study, so it was not surprising to find a large attendance of towboat men.

The first speaker, E. A. Slater of the Westinghouse Electric Company, outlined the reasons, such as maneuvering ability and pilot house control, which led the Pennsylvania Railroad to adopt the Diesel-electric drive, and proceeded to describe the engine cycle and the electrical circuit. Each of the two engines, running at a constant speed of 265 r.p.m., is direct connected to a generator and exciter, the main generators being connected in series, each supplying half the power to the motor which had a normal speed of 125 r.p.m.

The main fields are constantly excited by the exciter, which makes the speed and direction of rotation of the motor depend entirely upon the amount and direction of current in the armature circuits. This amount and direction of current is of course determined by the output of the generators, which are in turn controlled by the amount and direction of the exciting current supplied to the generator field windings. This is controlled by the reversing field rheostat located under the pilot house floor. This rheostat with the operating handle in the vertical or off position allows no current to flow through the generator field and consequently no power to be delivered from the generators to the motors. As the operating handle in the pilot house is moved forward, current is supplied from the exciter to the fields of the generators in direct proportion to the amount of movement; power is built up in the main circuit and applied to the motor causing it to turn in the ahead direction. If the operating handle is moved in the astern direction from the off position, the reversing rheostat reverses the current in the generator fields, causing the direction of the current delivered by the generators to be in the reverse direction, and consequently the direction of rotation of the motor is also reversed.

Curves were shown demonstrating that while the steam tug could only develop maximum power at maximum propeller speed, the Diesel-electric tug could develop maximum power all the time. Also that while the steam engine gave the same torque at all speeds, with the Diesel-electric drive very much more than the normal torque was exerted when the tug was slowed down owing to a heavy load, and when, generally speaking, it was most needed.



The navigator in the pilot house of the P. R. R. NO. 16 has complete control over the helm and propelling motor

The lecture was followed by a motion picture of the tug, showing how rapidly and readily she could be made to turn, stop and reverse. Part of the picture was taken in the pilot house and showed the very rapid rate at which the captain could operate the reversing handle. Our illustration shows that with one hand on the steering wheel he can with the other control the speed of the tug by means of the reversing handle on his right.

Captain E. A. Snyder then gave his own experiences with the tug. He opened his remarks by saying that he had operated steam tugs for years and had considered a certain boat the best thing in tugs that could be built. Since operating the Diesel-electric tug he had changed his mind, there was no comparison between the two. Control from the pilot house was a big improvement. Reversing from full ahead to full astern could be accomplished in six seconds, as fast as the lever could be pulled. He mentioned that a few steamboat men still required to be converted to the Diesel-electric drive; he would be glad to have them come aboard Tug No. 16, and if they did not change their minds he would be sorry for them.

Engineer Harland Hamilton then gave his discourse entitled "The Engineer's Viewpoint." The greatest difference in his opinion between the Diesel and the steam engine was the saving in time and trouble which resulted from the absence of steam, ashes, coal, water and boiler troubles. The tug could be run for 24 hours a day for eight days without refuelling. If one engine gave trouble it could be shut down and repairs could be made while the other engine carried on the work.

With the Diesel-electric installation there was no time wasted in getting ready for service, whereas with a steam tug there was always $\frac{3}{4}$ to $1\frac{1}{4}$ hours delay before starting. The engine developed full power all the time, there was no fluctuation as with steam. There were no leaky condensers or feed pumps to be dealt with, and above all—there were no bells!

F. L. DuBosque, Superintendent of the P.R.R. Floating Equipment, paid a tribute to the personnel of the boat, who, he said, had had no previous experience of Diesel work, but had quickly familiarized themselves with the machinery, and had tackled successfully all the problems involved in operating the tug.

Diesel-electric tug P. R. R. NO. 16 at work with a load of car floats in New York Harbor

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Readers are invited by the Editor to submit articles, photographs or drawings relating to motorships, marine oil-engines or auxiliaries. Contributions used in the magazine are paid for on the 15th of the title month of issue, and other contributions are returned as promptly as possible.

President's Committee Recommends Diesel Cargo-Liners

To study the shipping needs of the country President Coolidge appointed last March a special committee of cabinet officers, and the findings of this committee have just been submitted to the President. Maintenance of regular service of overseas trade routes of national importance by the Fleet Corporation wherever private enterprise will not undertake the task is one of the principal recommendations. The committee, however, urges that every effort should be made at all times to dispose of the various lines to private ownership even to the extent of taking immediate loss on the sale of ships, rather than continue their operation with the prospect of greater loss.

A partial set-back appears to be given to the proposed construction of the two large motor-liners for the Shipping Board of the GEORGE WASHINGTON type because the committee does not favor the further construction of large Atlantic type passenger vessels unless needed as auxiliaries by the Navy. The reason for this conclusion is that further construction would mean indefinite continuation of the government's ship fleet. At the same time recommendation for proper conversion of steamers to motorships of the cargo-liner type is made. This to cover the next five year period, after which new construction of cargo-liner type ships will be necessary says the Committee, which therefore recommends that conversion and construction activities be directed towards this type. Vessels of this character—especially of Diesel power—the report states, lend themselves to American genius and labor saving operation. Cargo-liner services contribute the most substantially to the distribution of our products abroad and recent studies of world's shipping indicate that the cargo-liner is replacing the tramp-ship to a considerable extent, and that the government can serve no useful service by undertaking to maintain a tramp service. It is also believed by the Committee that the requirements of a naval reserve for national defence can be largely fulfilled by the cargo-liner type of vessel. But, if the naval and postal authorities department consider that there is an interest for larger and faster type ships, then the construction and operation of such ships should be undertaken definitely upon naval and mail appropriations sufficient to cover the additional cost of construction and losses in operation. Such are the findings of the Cabinet Committee.

It may be recalled that for many years MOTORSHIP has drawn attention to the importance of the express type of passenger-cargo motorship or more generally known as the cargo liner and has urged their construction. Motorships of 14,000-16,000 tons deadweight and of 14-16 knots speed with limited but comfortable passenger capacity are vessels lacking and needed to balance our fleet for world-wide service. Twenty such craft, provided with adequate mail contracts could be made to pay, particularly under private ownership. Apparently the Committee put the onus of recommending the construction of the two large transatlantic passenger motor-liners up to the Navy & Postal Departments rather than to the Shipping Board. In this connection it is our understanding that the Navy has recognized the need for two more such auxiliary craft and so is likely to support the Shipping Board in its appeal to Congress for the necessary consent and appropriation.

Modernizing Our Inland Waterways Service

About ten years ago a young American engineer of Dutch birth foresaw the possibilities to be gained from replacing out-of-date coal-wasting steamers on our Great Rivers, and succeeded in securing sufficient capital to place several oil-engined craft of modern shallow-draft type in service. But John Bernard was a few years ahead of the time. He moved too swiftly for the old timers on our rivers with their puffing steam-driven stern wheelers burning seven to eight pounds of coal per horsepower hour. Many obstacles were placed in his way and the service sunk into oblivion.

For a period of six or seven years the oil-engine made virtually no headway on the Mississippi. Lately, however, our river-vessel owners have awakened to the economy of the oil-engine, and considerable interest has been aroused and quite a number of installations made. This has apparently been due partly to the stationary oil-engine—the economies of which have "forced" themselves upon a number of owners whose money was invested both on land and in the water. Seeing what its economy accomplished in their power-houses they naturally gave serious consideration to its adoption to their water craft. It is not surprising, therefore, to find that many of their first river installations were duplicates of what they used on land, namely horizontal units of the surface-ignition type.

Recently one of the big steel companies and the War Department, as well as several enterprising boat owners placed in service some stern wheelers driven by oil engines of the latest design and in some cases with electric drive. Such excellent service has been given by these vessels that activity has been stirred throughout our river system and we can look forward to hundreds of conversions and new motor vessels during the next few years.

An exhaustive study has been made of the subject by Brigadier-General T. Q. Ashburn, Chairman Executive of the Inland Waterways Corporation recently formed by the government. Not only has the new corporation under his supervision studied the problem of converting many or all of its power craft from steam to oil-engine drive in a serious way, but it is probable that some of these craft will be converted immediately sufficient money is available as has been previously indicated. It is anticipated that this step will do much towards avoiding further losses on the operation of the craft under its jurisdiction. Perhaps the most interesting and most forward of all the steps to be undertaken by the Inland Waterways Corp. is the early construction of two light-draft tow-boats of approximately 1,500 s.h.p., each of which are to be equipped with direct Diesel drive. Plans are now under way and it will not be long before bids are called on both the hulls and engines.

While shallow draft towing vessels of this power can be found in service on the Rhine and Volga rivers, these craft will form the highest powered Diesel-driven tugs yet contemplated in the United States either for river or sea-going service. General Ashburn is to be complimented on this most progressive movement which should do much to promote and furnish profitable traffic on our inland waterways.

The Editorial Index of the 1924 volume of MOTORSHIP is now ready and copies can be obtained by any subscriber writing to MOTORSHIP enclosing two-cent stamp. The price of this index to non-subscribers is 25 cents.

If any of our readers have copies of Lloyd's Register of Shipping published during the 60's, 70's or 80's, we will be glad if they will communicate with Capt. F. W. Wallace. Editor, *Fishing Gazette*, 196 Water Street, New York, N. Y.

Plans are now being drawn by the Inland Waterways Corp., Washington, D. C., for two light draft tow-boats of approximately 1500 s.h.p. each which are to have Diesel direct drive. Before long bids will be called by Brigadier-General T. Q. Ashburn, Chairman and Executive of the Corporation.

J. F. Metten, Chief Engineer of the William Cramp & Sons Ship & Engine Building Company, sailed for Europe on the S. S. PARIS on Jan. 7 for the purpose of visiting the plant of their Diesel engine licensors, Burmeister & Wain at Copenhagen, Denmark. The principal object of his visit was to witness the shop trials of the second of the new double-acting Diesel engines built by this well-known Danish concern. Mr. Metten is a pioneer in merchant marine type Diesel engine construction in the United States and through his company has been an important factor in its development and upbuilding.

Notes and News of the Month from Everywhere

World's Record of New Construction, Launchings, Trials, Ships' Performances and Other Events Connected with Motorships

A DIESEL-DRIVEN tanker, of about 17,000 tons is being planned by the Gulf Refining Co.

HENRY HORN, another 4600 tons motorship for the Reederi H. C. Horn of Flensburg, is due to run trials this month.

The new motor-liner AORANGI, which is equipped with a Sperry Gyroscope compass, arrived at Kingston, Jamaica, on Jan. 14.

Another 9400 tons gross motorship has been ordered by the Hamburg America Line from Blohm & Voss.

Trials of the converted steamer EISVOGEL have been run off Hamburg. The vessel is now a refrigerator type motorship.

URANUS and MARS are the names of the two motorships building for the Bergenske Co. at Brevik, Norway.

The Hamburg-South America Line's second reduction-geared Diesel-driven motorship MONTE OLIVIA has been launched and will shortly run trials.

A motorship with accommodation for 200 passengers and for crew has been ordered from the Georg Schuldt Shipyard at Stralsund by a shipowner at Rostock.

It is rumored that the Atlantic Refining Company are considering purchasing another tanker from the Shipping Board for conversion to Diesel-electric drive.

Report has reached us that two Diesel-driven steel ferry boats are under construction for operation in the spring between Clayton and Gananoque, Canada. They will replace two steam ferry vessels.

E. J. Sutton & Co.'s new 6600 tons 1500 s.h.p. Neptune Diesel-engined freighter has completed successful sea trials and has been taken over by her owners.

SORVARD, one of the ships built at Burmeister & Wain for Lauritz Kloster was launched during December. She is of 6,650 tons d.w. and is being fitted with twin 1,300 i.h.p. B.&W. Diesel engines.

ELMWORTH and OAKWORTH are the names given to two motorships building on the Clyde to the order of the Dalgliesh Shipping Co., Newcastle-on-Tyne.

District offices of the Busch-Sulzer Bros. Diesel Engine Company have been moved from 60 Broadway to 2 Rector Street, New York. Stanley Wright is in charge.

Of the principal steel tonnage built in American shipyards and documented during the first ten months of 1924, 11 out of 26 vessels, or 42 per cent, were Diesel-driven.

In less than three years the Deutsche Werft of Hamburg have built or laid down 22 Diesel-driven motorships aggregating 124,200 tons d.w. and 71,900 i.h.p.

LUBRAFOL, the 10,100 tons d.w. tanker built on the Tyne to the order of the Société Anonyme d'Armement d'Industrie ran trials on Dec. 6. Twin Armstrong-Sulzer Diesel engines propel this vessel.

Director H. Blache of Burmeister & Wain will read a paper dealing with the latest types of his company's Diesel engines before the Institute of Engineers and Shipbuilders in Scotland.

THISLEROS, 4700 tons gross motorship for Allen Black & Co., Sunderland, was launched at the Henderson Yard on Dec. 9 last. A Harland-B.&W. Diesel engine of 1850 s.h.p. is being installed.

According to C. E. Herring, U. S. Commercial Attaché at Berlin, 74 per cent of ships now being built in German shipyards are Diesel-driven. No fewer than 147 motorships aggregating 151,705 gross tons now fly the German flag.

Sir George Hunter, Chairman of Swan, Hunter & Wigham Richardson, Ltd., expressed himself as being enthusiastic over the future of the Diesel engine in the United States, upon his return to England, reports the Liverpool *Journal of Commerce*.

Two big 21,000 tons Diesel-driven ore-carriers now building at the Deutsche Werft, Hamburg, for Dan Bröstrom of Gothenburg, and which have been chartered to the Bethlehem Steel Co., have been named SVEALAND and AMERICALAND.

The Liverpool *Journal of Commerce* reports that high-speed Diesel engines of 12,000 s.h.p. and reduction-gears may be installed at a German shipyard in the Toyo Kisen Kaisha's passenger liners TENYO MARU and SHINYO MARU, which are to be converted into motorships.

It is reported that the order for the motor-tanker previously referred to in our columns has been placed by the French Navy with the Ateliers & Chantiers de la Seine, of Le Trait, near Rouen, France, at a cost of approximately 9,000,000 francs. The vessel will be of 6500 tons d.w., 384 ft. length, 52 ft. breadth and 32 ft. depth. Twin Penhoet-B.&W. Diesel engines of 1800 i.h.p. each are to be installed and they will be built by the Chantiers et Ateliers de St. Nazaire.

First of the big Sulzer Diesel engines for the Netherlands Steamship Company's passenger liner P. C. HOOFT now building in France started shop tests on Jan. 8, and was running at full load the next day.

Trials of the Sulzer-engined motorship ATAGO MARU have been run and the vessel sailed for Bombay.

Chas. F. Bailey, technical director of the Newport News Shipbuilding & Dry Dock Co., is now in Europe studying the Diesel engine situation on behalf of his company.

Burmeister & Wain are now willing to undertake the construction of passenger liner installations up to 80,000 i.h.p. in quadruple screw, four-cycle, double-acting Diesel engines, or sufficient power for the largest transatlantic ships.

When their motorship fleet now on order and in service is completed, the Roosevelt-Kerr-Kawasaki steamship interests will have vessels fitted with Neptune, Sulzer, Doxford and Fullagar designs of Diesel engines, and will represent about a dozen vessels altogether. All these engines are of the two-cycle type.

A passenger motorship with a capacity of 2000 has been ordered by the Hamburg Harbor Navigation Co. for service on the lower Elbe. The vessel is being built at the H. C. Stülcken Sohn yard at Hamburg and will be propelled by a M.A.N. airless-injection Diesel engine of 600 s.hp The vessel is a day-service boat and will operate on the lower Elbe.

Destined for propelling the motorship RABY CASTLE, building for the Lancashire Shipping Co. of Liverpool, tests on the brake in the shops have been made of an eight-cylinder four-cycle North Eastern-Werkspoor Diesel engine of 3000 h.p. at 92 r.p.m. The cylinders have a bore of 28.74 in. by 51.18 in. piston stroke, and this engine was illustrated on page 913 of our December, 1924, issue.

Burmeister & Wain are making another increase in capital bringing the same to 20,000,000 kroner, according to the Scandinavian Shipping Gazette. This has been found desirable because of recent extensions to the company's engine works and shipyard. The capital was 12,000,000 kroner, which in 1924 was increased to 15,000,000 kroner, so that the present increase means another 5,000,000 kroner.

From Burmeister & Wain, Copenhagen, has come a very interesting bulletin dealing with the various motorships equipped with Diesel engines of their type. A list is given of their motorships put in service between 1912 and Sept. 2, 1924, of which there are 152 vessels with engines aggregating 451,355 hp. excluding auxiliary engines. The company now has 12 licenses. A chart is given showing the number of vessels with Burmeister & Wain Diesel engines in comparison with those of other makes.

Sketches and Working of Oil Engines*

Combustion Characterizes the Oil Engine—The General Process —Supplying the Fuel—Atomizing the Charge— Combustion Pressures—Temperatures

OF the various systems used for igniting the charge in an internal combustion cylinder the one which depends upon the heat of compression is perhaps the simplest. That is true as far as the igniting process itself is concerned; whether or not the engine as a whole is simplified by the use of compression-firing will develop as this study progresses.

Heat due to compression is depended upon more or less in all internal combustion machines to assist ignition; everyday experience with gasoline automobile engines teaches that an engine with diminished compression is generally harder to start than one which is compressing properly. Combustion, whether due to compression or other agencies, is a chemical process in which the development of heat is an important factor. It cannot begin unless the air and combustible are both first raised to a definite temperature and it cannot continue unless that temperature is maintained. The beginning of combustion, known as ignition—is generally brought about by locally raising the fuel and air temperatures from an outside source above the point where combustion can take place. The continuation of combustion is then made possible because of the heat liberated by the combustion process itself; in fact combustion cannot be said to exist unless the process furnishes itself with the heat which it requires.

Reserving a more extended consideration of this interesting subject to a later chapter, it will be sufficient for present purposes simply to outline the more salient points bearing on oil engine combustion.

It is the combustion process and the pressures associated with it which gives the oil engine its most strongly emphasized features. Not only the moving parts of these machines, but also their frame construction have been profoundly influenced by it.

Combustion Characterizes the Oil Engine

In deciding which to study first—the structure of the oil engine or its combustion systems—it is important to note that neither one can be fully understood without the other. However, since it is probably more correct to say that combustion is the cause and the structure the effect, a good many would decide in favor of concentrating on combustion first.

Most oil engine combustion systems produce a combination of heat and stress such that mechanical engineering problems of a peculiar nature are created. It may be said in a general way that these problems, which are to be extensively treated in subsequent chapters, vary as the cube of the cylinder dimensions of the engine under consideration. It takes eight times as much knowledge, care, and skill to build a successful 40-in. Diesel engine cylinder (Fig. 10), as it does to build a 20-in. one. An expedient which is entirely safe for a small machine may wreck a large engine at the first firing stroke.

Have the problems pertaining to oil-engines been solved is therefore not a useful way of putting the question. It would be more intelligible to ask what is the largest power which can be successfully developed in a single oil engine cylinder.

In the earliest stages of the oil engine's development it became a success at the instant when it was able to develop sufficient power to permit an engine of a commercial size to be manufactured and offered for sale. With oil engines, as with most things, success consists not so much in a single event, as in a succession of difficulties overcome and in advancing progress. A good barometer of oil engine progress is the size of the units in which they are being commercially offered. Because of the determining influence of size already referred to it is quite safe to say that if 30-in. cylinder sizes are successful 25-in. machines may be accepted as an absolute certainty. To be sure, there is also a lower limit for workable oil engine cylinder sizes, which have peculiarities of an entirely different nature. This limit, too, is being extended and the successful combustion of heavy oil in an engine having a bore of 4 in. and running at 1300 r.p.m. is in some ways as remarkable an achievement as the production of 2000 h.p. in a single cylinder (Fig. 10).

On the whole, however, the greater amount of effort appears to have been directed towards the production of the larger units. The story of the achievements which have been made with them is the story of the engineers' battle to win control over the conditions of pressure and combustion. Of negligible consequence in relatively small cylinders, they become the heart of the problem in engines of larger capacity.

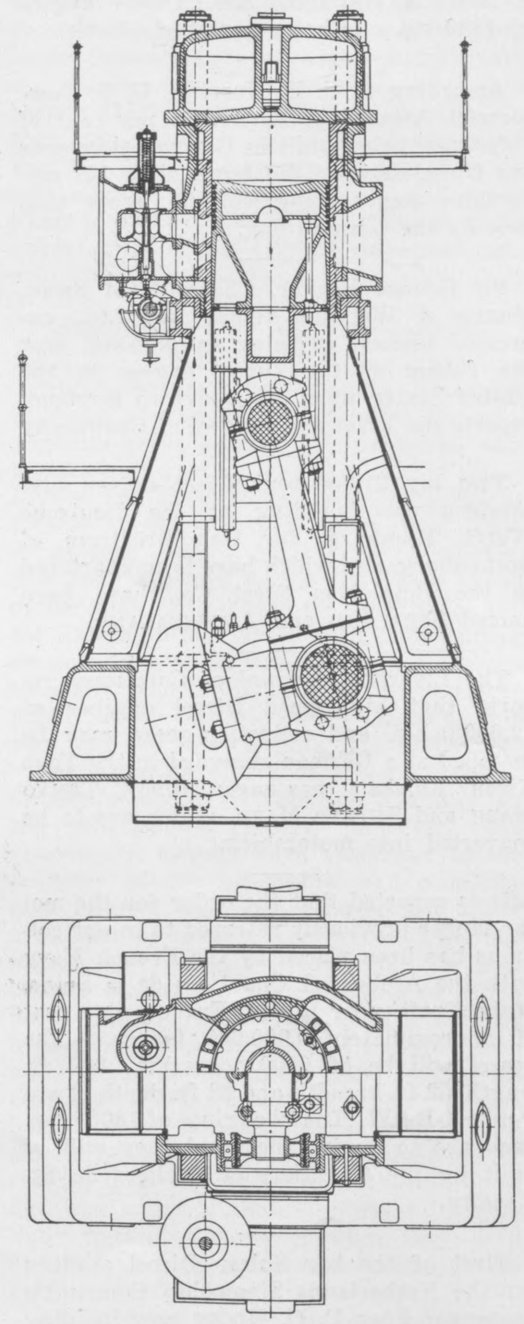


Fig. 10. One-cylinder single-acting engine, 2000 s.h.p., 39.4" x 43.3", 115 r.p.m. Piston load, 300 tons

The Two-Stroke Cycle

A general outline of the principles according to which the oil engine operates has already been given. Since there is no fuel present in the air which is introduced into the cylinder, this part of the oil engine cycle is simpler than that of the gas engine, where the suction stroke is utilized for the formation of an explosive mixture. Compression is carried to such a point in the oil engine that it produces a temperature sufficient for the ignition of the fuel which is sprayed into the cylinder at or near the dead center. The expulsion of the gases is accomplished in the same way as that which characterizes gas engines.

The method of operation which has thus been outlined is known as the four-stroke cycle and is accomplished in two revolutions of the engine crank. Only the compression and expansion strokes are actually concerned in the power processes and the suction and exhaust strokes hardly do more than merely to accomplish the transfer of low-pressure gases.

Detailed consideration will be given later to the two-stroke cycle, in which these gas transfer processes are carried out without sacrificing two full strokes to them. Since there is no fuel present in the fresh air charge, the problem of substituting it in place of the spent gas is considerably simpler than it is in gas engine operation, where the contact between explosive mixture and exhaust gas favors waste and in back-firing. As far as compression and expansion in oil engines are concerned, there is no difference in principle between the four and the two-stroke cycle. The framing and major moving parts of the two types of engines are the same and it will be found as this study continues that really essential differences are limited to the construction of the cylinders, pistons and cylinder heads.

The General Process

Ignition in both the two and the four-cycle engine is brought about by the contact between the small particles of oil and the highly heated compressed air into which they are projected.

The fuel which is to be introduced into the cylinder for a given working stroke is deposited by a small fuel pump above the seat of a needle closing off an orifice leading to the cylinder. Surrounding the needle is a supply of compressed air having a pressure from 600 to 1000 lbs. per sq. in., always considerably in excess of that which occurs in the cylinder at any time.

When the needle is lifted, the ensuing rush of compressed air into the cylinder breaks up the oil into finely divided particles which expose a large aggregate surface to the action of the highly heated air in the cylinder. The air blast also serves to distribute the oil particles uniformly throughout the combustion space and to bring the largest possible number of them into contact with the oxygen needed by them for combustion.

It is by no means sufficient in general merely to pump a stream of oil into the combustion space. In the original developments of the Diesel engine direct hydraulic injection of the fuel was given up after having been attempted and although substantial achievements have recently been made with this method, the use of compressed air for spraying the oil into the cylinder still receives widespread recognition as a standard method.

A high-compression engine using air injection is shown in cross section in Fig. 11, and is illustrated in a general way in Fig. 12. The

*Summary of a course of instruction at the Polytechnic Institute, Brooklyn, N. Y., by Julius Kuttner, B.Sc., Licensed Chief Engineer, Associate Editor of MOTORSHIP. This is the second chapter, the first having appeared in the January, 1925, issue.

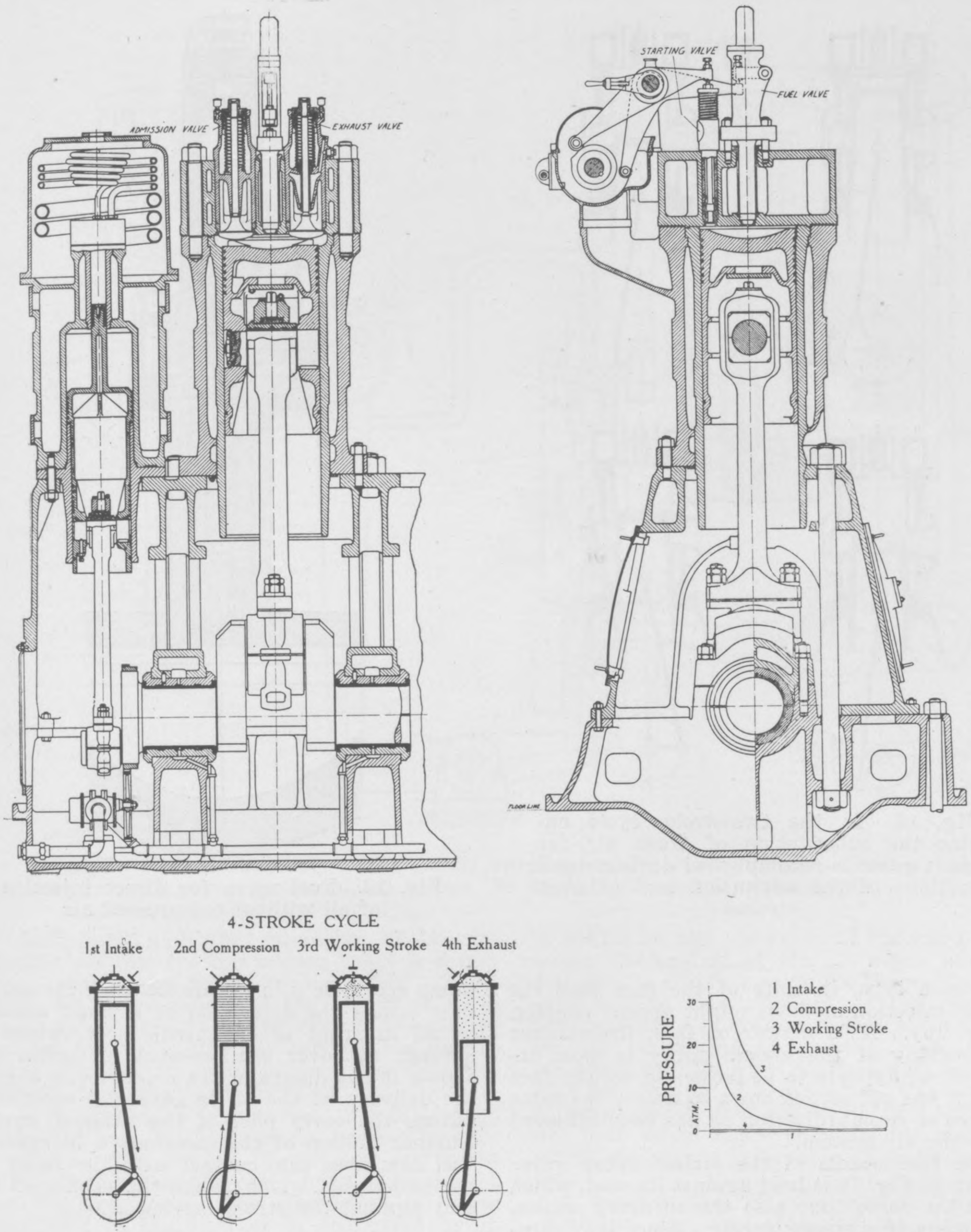


Fig. 11. Cross section of a Diesel engine closely resembling the one shown in Fig. 12. On the centerline of the working cylinder is shown the fuel valve and at the left the three-stage air compressor with its intercoolers is visible

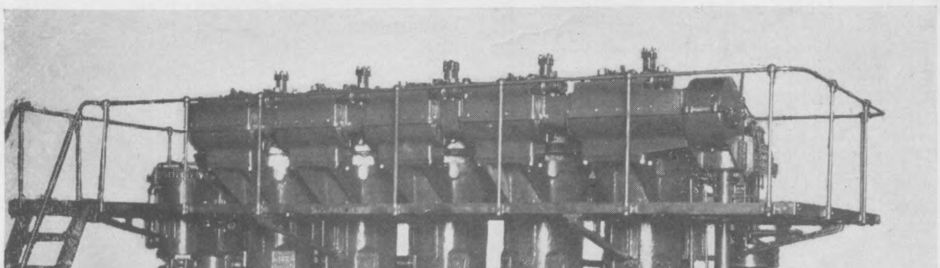


Fig. 12. General view of typical Diesel engine showing compressor at rear and governor and fuel pump behind flywheel. Fuel valves are seen projecting at the top

framing, crankshaft, connecting rod, and piston show no unusual features. Although there is no such thing as a "standard type" of Diesel engine in existence at present, the one here illustrated strongly resembles the designs which have been adopted by a considerable number of manufacturers and which are the likeliest to be met with in practice.

Worthy of note is the compressor shown at the left of the cross section, Fig. 11. It has three stages with intercoolers and furnishes air for starting and fuel-spraying purposes. Another view of a multi-stage compressor of the kind similar to that generally used for Diesel engines is shown in Fig. 13.

The principles according to which the engine shown in Fig. 11 operates and which have been already outlined in the preceding paragraphs, are schematically illustrated in Fig. 14.

To the uninitiated the starting and operation of a device such as that illustrated may possibly be a puzzle, particularly if he has been duly impressed by what has been said about compressing to 480 lbs. per sq. in. The starting air bottle *c* is sometimes shipped charged by the manufacturers and is available for giving the engine its first turn over; it may also be filled from a hand-started air compressing set. The same applies to the injection air bottle *b*.

Whereas the exhaust and inlet valves *g* and *e* (Fig. 14) always operate whenever the engine is set in motion, the spray valve *f* and starting valve *m* are arranged on eccentric fulcrums which permit of either one or both of them being thrown out of action. While starting it is generally considered undesirable to allow any fuel to enter the cylinder. After the engine has been allowed to make a few turns on compressed air from the bottle *c*, the valves *m* and *f* are switched and normal operation on fuel commences. The attached compressor *j*, *k*, has a capacity sufficient not only to supply the injection air needs, but is capable of refilling the starting air bottle *c* as well. After that has been done all the valves on this bottle are closed and the suction to the compressor is throttled in such a way as to maintain the delivery of air to the fuel valve at a suitable pressure. All these operations may be appropriately arranged in the case of direct-connected marine engines for convenient control and reversing at the "throttle."

Many variations as to detail are naturally encountered both in the design and manipulation of high-compression oil engines, not the least of which is determined by the use of airless fuel injection. What has been said is intended to serve merely for the purpose of a general orientation on the basis of which a detailed consideration of constructive and operating principles is to be built up in subsequent chapters. The high-compression oil engine principle lends itself to an almost infinite variety of practical applications; like the steam engine cycle it may be realized in horizontal, vertical, marine, stationary, high-speed, low-speed, single-cylinder and multi-cylinder types.

It is still too early in the development of the art to permit of distinguishing accurately general principles underlying oil engine design and operation. The best that can be done at present is to study those tendencies which have repeated themselves often enough thus far to make it appear as though they might ultimately crystallize into well-defined principles. Because of this fact it is not intended to convey that engines or systems which depart from those ideas which are being tentatively laid down as "principles" are necessarily bad. What might be regarded by some as standard practice today may possibly be considered gross blundering tomorrow. In this course of study principles are to serve merely as pegs on which to hang ideas and observations from practice.

Supplying the Fuel

Insofar as combustion in the oil engine is associated with forces and temperatures higher than those commonly met with in ordinary mechanical engineering practice, it is necessary for the student to acquaint himself with the fundamentals of the fuel supplying process. A representative form is discussed in what follows. Air injection is chosen as a

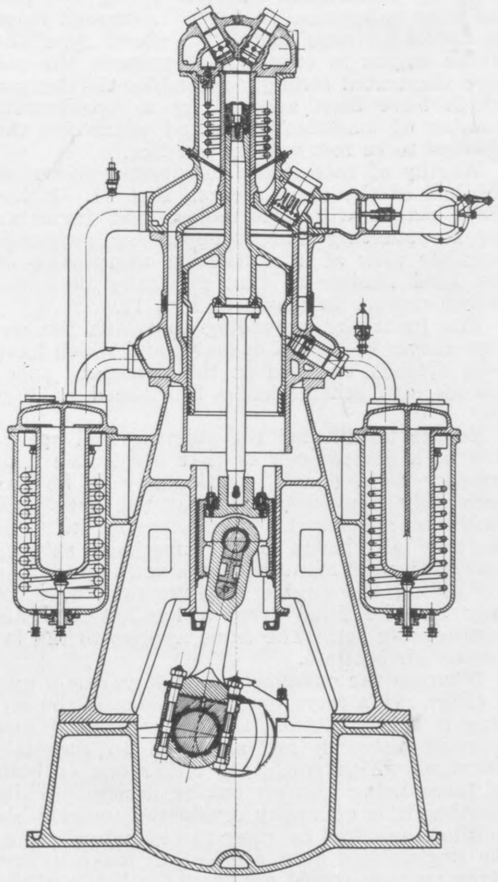


Fig. 13. Cross section through Diesel engine air compressor showing intercoolers and some of the valves for each of the three stages

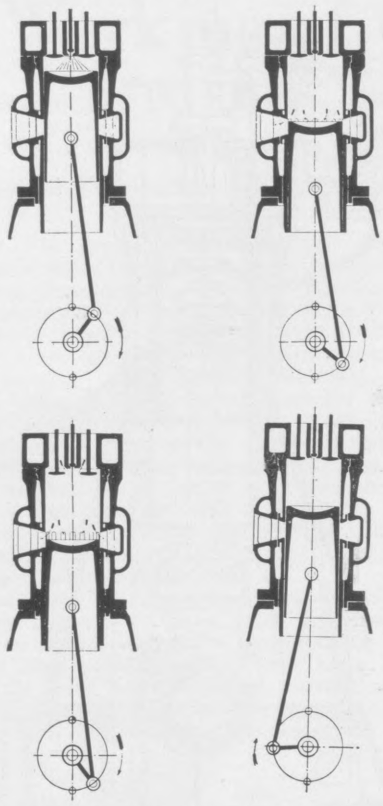


Fig. 15. In the two-stroke cycle engine the substitution of fresh air for spent gases is accomplished during small portions of the expansion and exhaust strokes

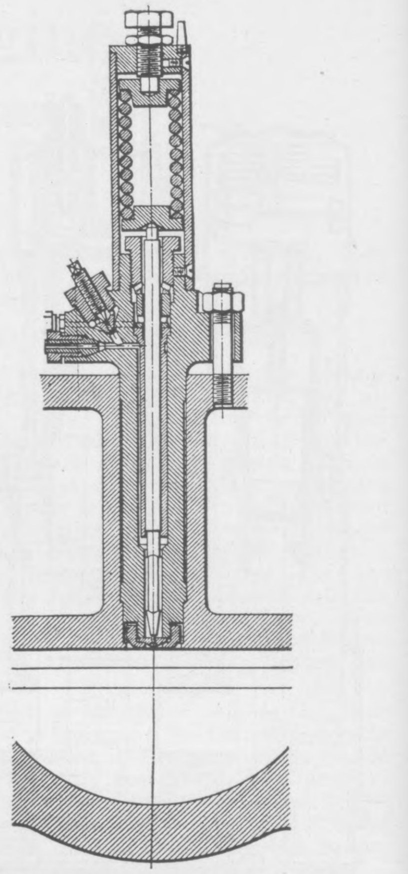


Fig. 16. Fuel valve for direct injection of oil without compressed air

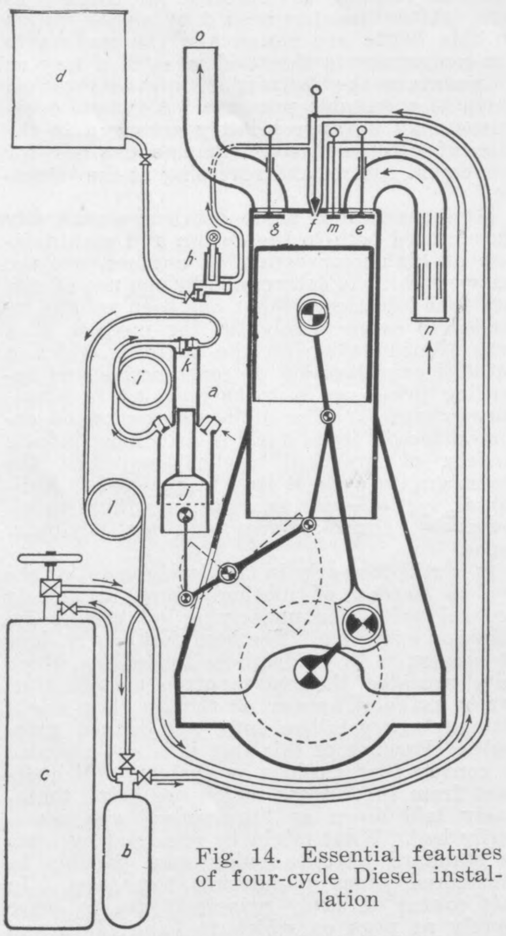


Fig. 14. Essential features of four-cycle Diesel installation

a. Air inlet to low stage of compressor
b. Injection air equalizer and storage flask
c. Starting air storage flask
d. Fuel oil supply tank
e. Air inlet valve to working cylinder
f. Fuel valve
g. Exhaust valve
h. Fuel pump
i. Compressor intercooler
j. Compressor L.P. cylinder
k. Compressor H.P. cylinder
l. Injection air cooler
m. Starting valve

specimen type, in spite of the fact that the direct-injection methods might appear simpler. (Fig. 15). As a matter of fact, the manner of working of the airless spray is more involved, as appears to be borne out by the fact that it has not settled down to nearly the same degree of standardization as has been achieved with the air system.

The fuel needle of the airless spray valve shown in Fig. 16 is held against its seat, which is at the same time also the spraying orifice, by means of a strong spring. Since it is carefully packed to prevent the escape of oil, it is capable also of acting as a piston and will move outward against the spring in response to a pressure impulse from the fuel pump. As a result of the pressure rise the needle moves away from its seat a few ten-thousandths of an inch and allows a small amount of oil to pass at high velocity and to become finely divided.

A detailed consideration of the various systems is to follow in a later chapter; the main object in touching on the subject at this point is to pave the way for the study of major oil engine parts such as framing, cylinders, pistons and the like. The construction and working of these parts is not directly affected by the particular injection system which is used in connection with them. At the same time these parts are all affected alike by the high pressures and temperatures which are common to all injection systems.

In the fuel supply system diagrammatically outlined in Fig. 17, a fuel valve *t* and the fuel pump for supplying it are represented. The pump merely delivers oil to the sprayer and has finished its stroke considerably before injection actually begins.

Like any pump it consists essentially of a plunger working between two check valves. The plunger in this case is *k*, the suction check valve *l*, and the discharge check valve *j*, while the regulation of the amount delivered is accomplished by means of the tappet *r* and control linkage *c*. Suitable high-pressure tubing and a drilled passage connect the oil supply to the base of the injection valve cage, as has already been mentioned. Since the needle is constantly surrounded by high-pressure injection air, it is obvious that the fuel pump must be capable of delivering against this air pressure.

Rotation of the fuel valve cam and fuel pump eccentric *u* in the direction of the arrow first causes the deposition of a small amount of oil in front of the needle seat, where it spreads out over checker-work or baffles not shown in the diagram. In a four-cycle engine the delivery of the oil is generally completed during the early part of the exhaust stroke. Further motion of the camshaft *u* brings the fuel cam nose into contact with the roller on the bell-crank, which raises the needle off its seat against the strong spring *w*.

Atomizing the Charge

Lifting of the needle occurs slightly before the completion of the compression stroke, at a time when a temperature of incandescence has been established in the air itself. As the compressed air in the needle cage rushes past the end of the needle it picks up small droplets of the oil which have been deposited there and carries them at high velocity past the orifice *t*, where they are broken up into a mist so fine that its particles are capable of floating in the air like smoke. It is interesting to set up a spray valve like that shown in Fig. 18 with all connections on the work bench and then to strike the needle lifter a blow with a hammer. The discharge which then issues from the orifice resembles a fine mist and makes it difficult to believe that it originated from a black sticky mass of fuel oil. Anyone who has ever used an air hose for blowing out oily castings knows how a jet of air will pulverize even viscous oils.

Needless to say, the aggregate surface of oil particles introduced into the combustion space by the spray valve offer a considerable area to the action of the heat and permit the ready escape of a sufficient quantity of oil vapors for the formation of a combustible mixture with the compressed and heated air in the cylinder. At the same time the action of the jet sends the small particles to the farthest corners of the combustion space and prevents local over-saturation.

When it is considered that something like 0.005 of a second elapse between the time when the needle first begins to lift and when combustion is in full swing, some idea of the importance of spreading the oil out over a large surface may be gained. If the particles are thick it takes a longer time for the oil at their centers to come into contact with the air.

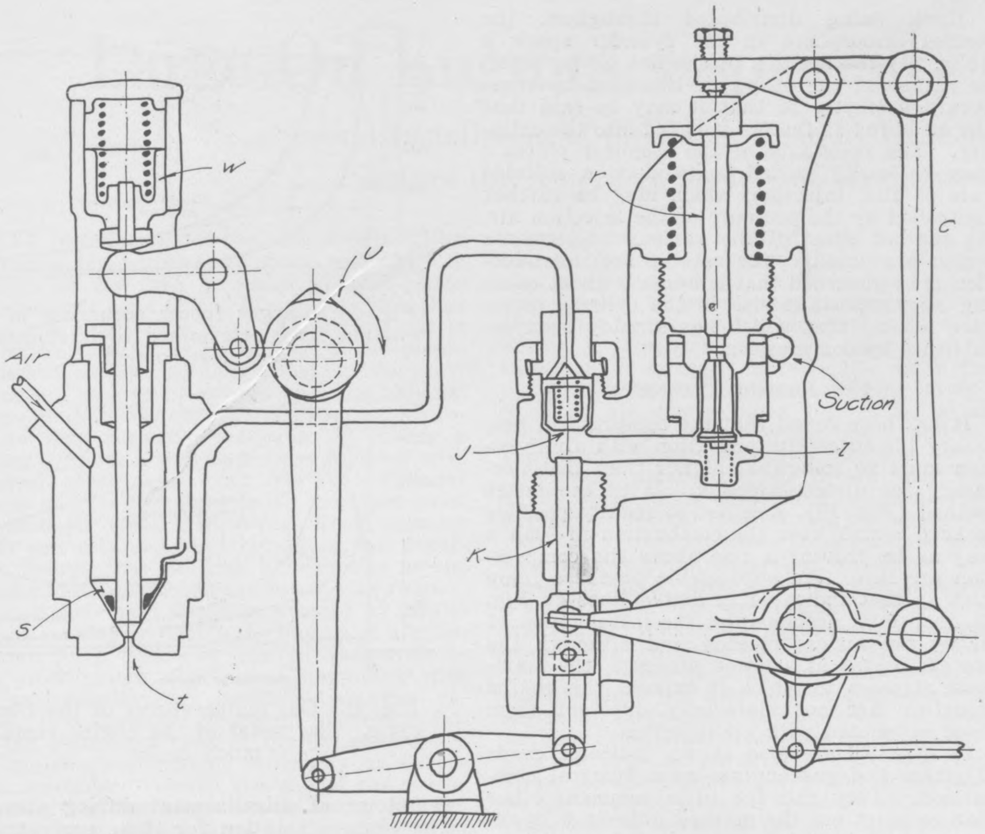


Fig. 17. Fuel is supplied to atomizer in varying amounts to suit loads. Delivery at *s* is generally completed before the needle lifts and injection begins

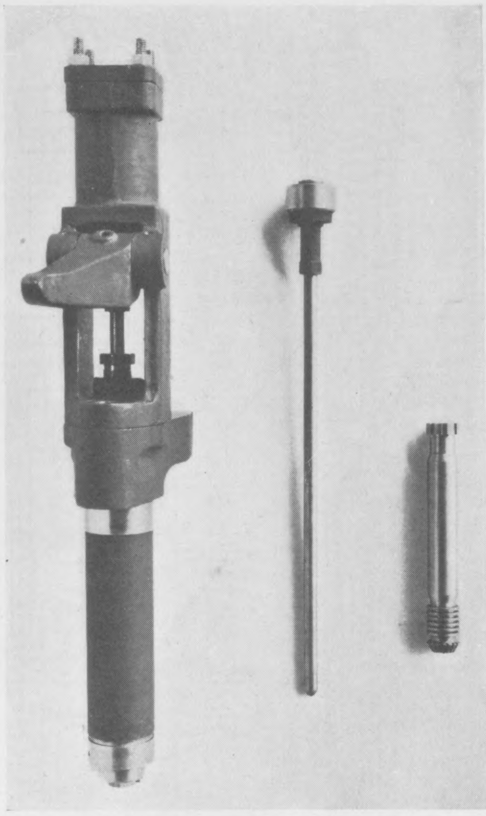


Fig. 18. Fuel injector showing needle valve and atomizer, which works with compressed air

Associated with the expansion of the injection air into the combustion space is a certain amount of refrigerating effect. However, since the weight of the air which is so used rarely exceeds 10 per cent of the air required by the engine for combustion, its actual effect in reducing temperature does not constitute a practical difficulty.

It is important to note that the fuel pump takes no part in the injection process as thus outlined. The control of the load and speed of the engine, on the other hand, does depend on the pump, since the amount of oil made available to the sprayer is controlled by it. On the indicator diagram (Fig. 19) the effect of varying quantities of oil injected is plainly visible in the thickness of the card. The larger the amount of the oil which has been delivered to the fuel valve the longer the pressure will be held constant as the result of combustion. Combustion ceases shortly after the fuel valve has been swept clean by the air blast, and its cessation has nothing to do with the closing of the needle. The latter is so timed that it does not seat before all the oil has been swept out even when the maximum which the engine is capable of using is being fed.

A cross section of an actual fuel valve is shown in Fig. 20. The separate inlets for the fuel and air are plainly shown and around the base of the needle are placed the perforated baffles already referred to. What their action is may be somewhat better understood by reference to the atomizer diagram shown in Fig. 21. It is not intended that this illustration should be regarded as strictly accurate in all its details; it is offered for the purpose of assisting the student in making some kind of a mental picture of the processes which go on inside of an oil engine atomizer.

Stopping up the entrance to the cylinder (Fig. 21) is the needle valve *d* already referred to as being arranged for mechanical actuation. In the same space *a* is the supply of compressed air maintained at a pressure almost twice as great as the maximum which is ever produced in the cylinder space *g*. Sur-

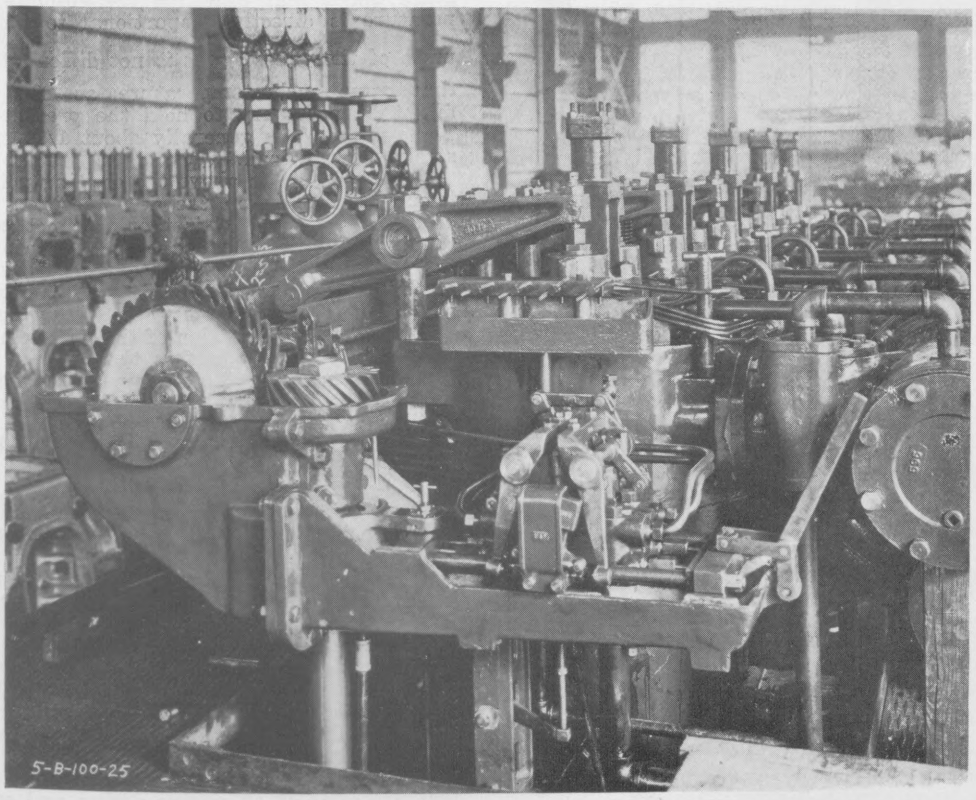


Fig. 17a. The fuel pump (small mechanism next to cylinder) delivers individual charges of fuel to the spray valves. A characteristic method for driving the pump and all the engine valves is also shown

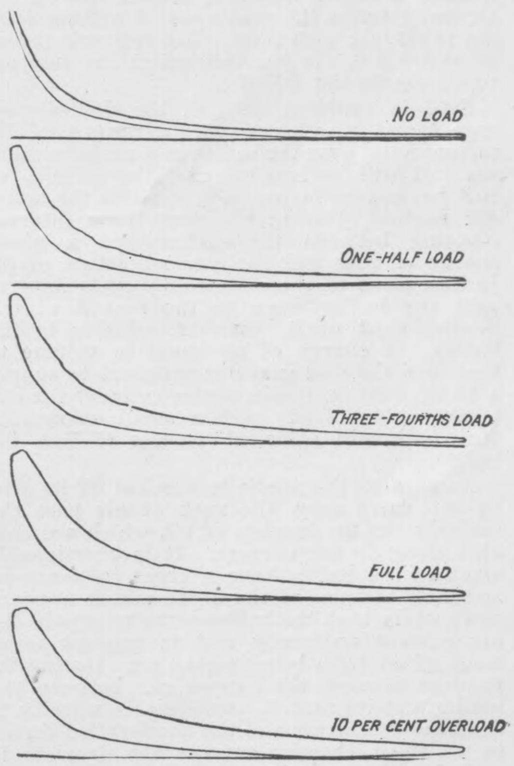


Fig. 19. Regulation of Diesel engine is accomplished by varying the fuel charge injected

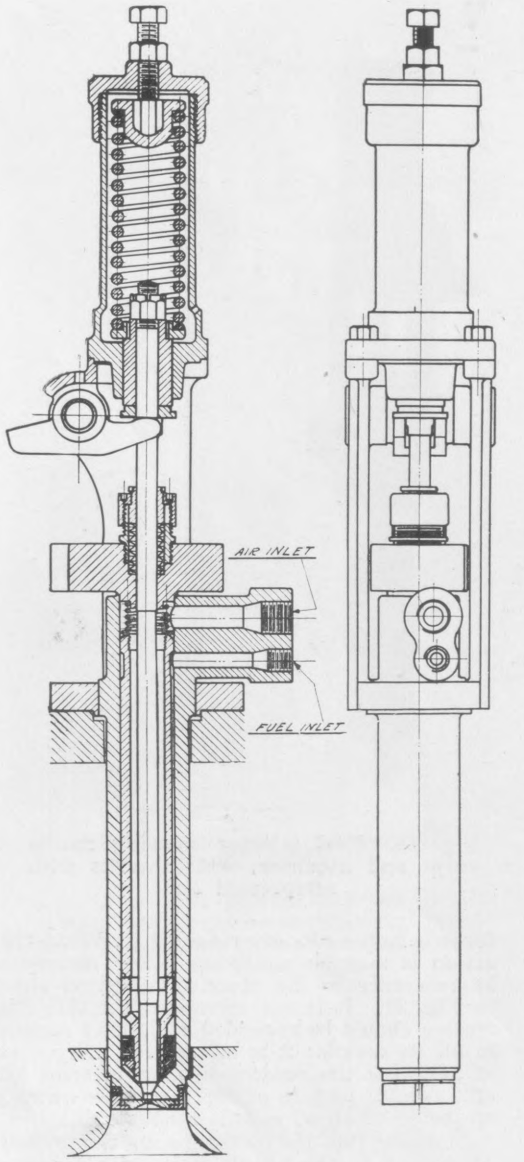


Fig. 20. Spray valve showing fuel and air connections

rounding the needle is a sleeve guide fitted with perforated baffles at its outer circumference in such a way that neither fuel oil nor air can get past the needle seat *h* without coming in contact with them. The reducing throat or orifice *f* is the point at which the fuel actually enters the cylinder.

Fuel is supplied through the drilled passage *b* and is in some cases arranged to distribute itself over the baffles in a uniform manner. It will be recalled that the delivery of fuel has ceased before injection into the cylinder begins. During the short time interval elapsing between the delivery of a given charge of fuel and the commencement of injection, some of the oil possibly finds its way past the baffles down to the seat *h* of the needle; most of it, however, adheres to the baffles. A charge of oil equal in volume to that of a Concord grape is sufficient to supply a 13 in. x 20 in. Diesel engine cylinder for one stroke at full load; such a small amount of fuel is barely sufficient merely to wet the baffles.

As soon as the needle is knocked off its seat by the valve gear, the rush of air past the baffles picks up droplets of oil, which are carried along in the current. It is questionable whether the baffles have a great influence on reducing the size of the drops and it appears more likely that the baffles serve to supply the air current uniformly and to prevent large slugs of oil from being picked up. During its passage through the narrow gap between the needle and its seat *h*, considerable velocity is acquired by the air and the acceleration forces to which it thereby exposes the droplets is probably the most important agency for pulverizing them. In the orifice *f* the air velocity is highest and it is probably there that the atomizing action is most pronounced.

Upon being distributed throughout the heated atmosphere in the cylinder space *g* (Fig. 21) the ignition of the fine oil particles, or rather of the oil vapor liberated by them occurs promptly so that it may be said that the oil burns as fast as it is fed into the cylinder. The resistance of the atomizer plates *c* may be easily varied to produce a suitable rate of fuel injection, which may be further controlled by the pressure of the injection air. As the net effect of the various adjustments which are possible, the rate of fuel introduction is so governed that it burns without causing any important rise in the cylinder pressure beyond that which has already been established by compression.

Combustion Pressures

It has been found that the compression necessary for successful operation with air injection must be somewhat higher than that necessary for direct injection. With the latter method (Fig. 16), it is not so readily possible to keep control over the combustion in such a way as to prevent a rise above the compression pressure. An appreciable pressure jump such as that indicated in dotted lines on Fig. 22, therefore, accompanies the introduction of oil by the airless method and although the process begins at a lower pressure, the maximum stresses to which it exposes the engine structure are not materially different from those associated with air injection.

On Fig. 22 are also shown indicator cards of steam and gas engines as a basis of comparison. They call for little comment other than to point out the marked difference in engine practice which has resulted from the introduction of oil engines. Not only the stationary, but also the moving parts of these mechanisms are subjected to heavier loads than those heretofore commonly met with in the older forms of prime movers.

In spite of the greater stresses which are met with actual breakages of oil engine parts are no more common than with other machinery. On the other hand problems of a subtler nature have been produced and the successful solution of the latter is signallized by the staggering increases which have recently occurred in the oil engine industry. Possibly the most important of the mechanical puzzles which have arisen out of the large forces occurring in oil engines is the occurrence of deflections and elastic deformations rather than direct failures. Bearings perfectly alined in an engine at rest have been found to give all the symptoms of misalinement during operation. The obvious solution for these early troubles has been found in locating metal sections and engine members in such a way that they offer a high resistance to deflections. Many examples of this are discernible in current practice and will form an important part of the material treated in this course of study.

Temperatures

Another one of the characteristic oil engine problems which have been found capable of being solved, at least in cylinder sizes such as are currently met with, is that arising out of the high temperatures which are produced. Fig. 23 shows a "temperature indicator diagram" based partly on observations and partly on calculation. The captions on the figure make it largely self-explanatory. As a maximum temperature 2900 deg. F. is indicated, a temperature which is calculated from the condition that the pressure in the cylinder is maintained constant up to the point of cut-off. Since under that condition the absolute temperature is directly proportional to the volumes of the gases $\frac{V_2}{V_1}$ it is not difficult to see that some such temperature as 2900 deg. might be necessary to hold the pressure up. The volume V_3 is generally about 1/11 of the stroke for full load.

But 2900 deg. is above the melting point of iron, not to mention the decomposition point of lubricating oil. It is therefore not unreasonable to assume that this temperature is actually established only at the central core of the combustion space and that the outlying air volumes are not nearly so highly heated. At all events the duration of the high-temperature period is only a few thousandths of a second. The iron of oil engines does not, as a matter of fact, melt. Cylinder walls and pistons of such machines which have been running for years on end show signs of being well lubricated, although lubricating oil with a flash-point not much above 400 deg. F. was used.

In conclusion it may be well to point out that there is plenty of mechanical apparatus working at temperatures higher than those which are averaged in internal combustion engines using heavy oil as fuel. Boiler flues and heat-treating furnaces attain higher actual metal temperatures than those commonly met with in oil engine practice. There is also a large class of machines such as hydraulic presses which handle larger forces. It is the combination of heavy loads with high temperatures that has made up one of the central problems of oil engine design and operation. How it has been overcome and a serviceable type of machine produced is the story which is being told here.

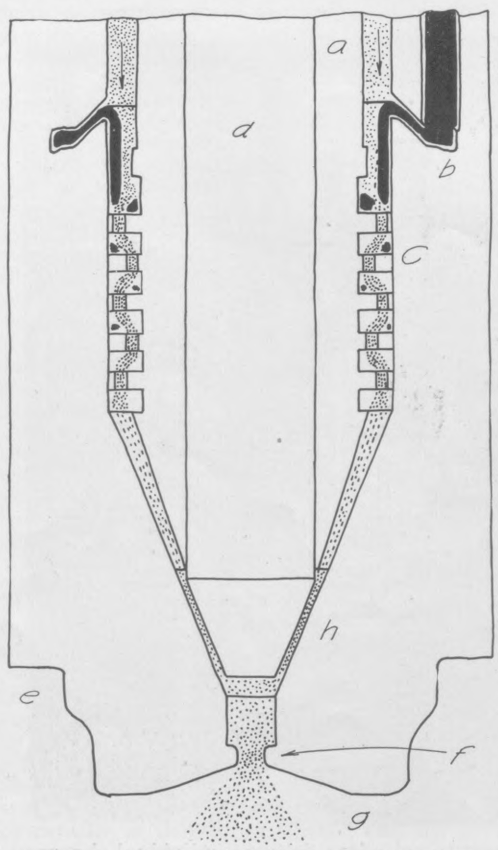


Fig. 21. Production of spray in air-injection engine

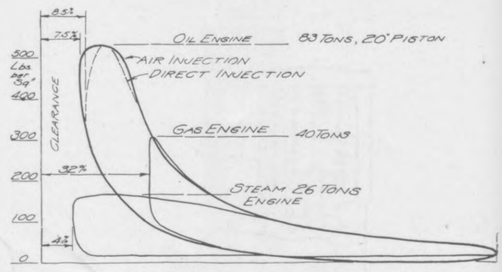


Fig. 22. Larger forces occurring in oil engines have determined their structure and development

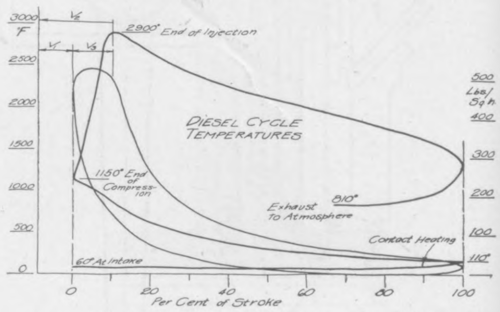


Fig. 23. Gas temperatures of the Diesel cycle. The metal of the engine remains much cooler

Large Oil Engines, Especially the D.-A. Type*

Second Installment of the Paper Read by Dr. Chas. Edward Lucke Before the American Society of Mechanical Engineers

NEXT in order comes the true double-acting piston, but without the piston rod, which in relation to the two previous opposed-piston plans accepts part of the ideas for which they stand and rejects the rest. As worked out in the North British design of Fig. 3, the piston rod is still avoided as dangerous, but the scavenging-air admission at one end and exhaust escape at the other end are retained as desirable, so very desirable indeed as to justify a moving cylinder acting as a valve member with a novel mechanism both for the cylinder sleeves and for the piston with wrist-pin passing through slots. However, fixed cylinder heads are retained, and herein is one difference, though they do look like pistons as the cylinder slides past, and are fitted with rings.

Piston rods have not been avoided by all designers seeking to double the output of a cylinder, nor have they ever proved dangerous or even troublesome where used, beginning with the well-standardized double-acting gas engines. It is therefore of special interest to follow the piston-rod type or normal double-acting engine development, especially as to the ideas involved. Toward the end of the period of perfecting the large double-acting gas engine, practice settled down to the adoption of the four-cycle horizontal tandem arrangement, the two-cycle having been abandoned because of the losses of gas at exhaust ports during scavenging and in spite of its greater simplicity of mechanism even with valve scavenging. Design had become pretty well standardized and service reliability well established.

Reduction of clearance between piston and cylinder head to get high compression made a clearance pocket at each valve, one under the inlet on top and the other above the exhaust valve under the cylinder, as in Fig. 4, illustrating an Augsburg design.

This design is obviously unsuited to marine work, and has other limitations, more or less apparent, which limit its interest; but the vertical designs, inherently lighter, are of special interest, especially those that are operating two-cycle, in view of their greater simplicity and their attainment of maximum possible number of impulses with consequent promise of least weight per horsepower, as well as maximum horsepower per cylinder, subject to proof that piston rods will give no trouble, that cylinder heads are safe, and that cylinders working in both ends can be held so as to permit complete freedom of expansion of heated parts. To this must be added, also subject to proof, that combustion conditions can be as good in double, as in single-acting, it already having been established that they can be as good in two-cycle as in four-cycle, and that side-port scavenging gives as good an air charge as a four-cycle, so that nothing can be gained by the end-to-end scavenging of the opposed-piston engines.

Without attempting to review the whole of the work along these lines, there are three engines of special interest, all two-cycle. The first one invites attention from the fact that it was the first double-acting oil-engine to be installed in a ship, the German motorship FRITZ. Fig. 5. The working cylinder used valve scavenging, thus retaining the idea that proper scavenging requires admission and outlet to be at opposite ends. Put into service in 1915, it represents the first practical outcome of a series of large-scale developments of double-acting-engine ideas conducted by M. A. N., begun in 1910 in an effort to develop Diesel ships for the German Navy and extending up to the present time. The last published outcome of this series is the double-acting, two-cycle, port-scavenging design of Fig. 6, the research work having demonstrated the complete effectiveness of port scavenging for the double-acting two-cycle as had previously been demonstrated for the single-acting.

Finally, in this series of developments of double-acting engines of the simplest arrangement of major running parts, with the plain piston rod and with the simplest of cylinder charging arrangements—that of the two-cycle port-scavenging—there is to be noted the Worthington design, which carries simplification of the cylinder and heat structure further than before. This is a forged-steel shell, including head and most of one half of the cylinder, Figs. 7, 8, 9 and 10, shaped somewhat like a hollow projectile at each end, with the parts held together and against a base plate carrying ports and frame connections near the middle. A thin cast-iron liner provides a piston rubbing face, and a cast-iron outer shell forms the water jacket in such a way as to permit complete freedom of expansion of the heated member, while the long bore of the central base or frame member assures axial alignment for free working of the piston.

This cylinder construction by the use of forged steel is thinner than one of cast iron, in inverse ratio to the allowable working stresses, roughly one-third, and is wholly free of joints or webs which involve localization of expansion stresses, though its ductility compared with cast iron makes it capable of

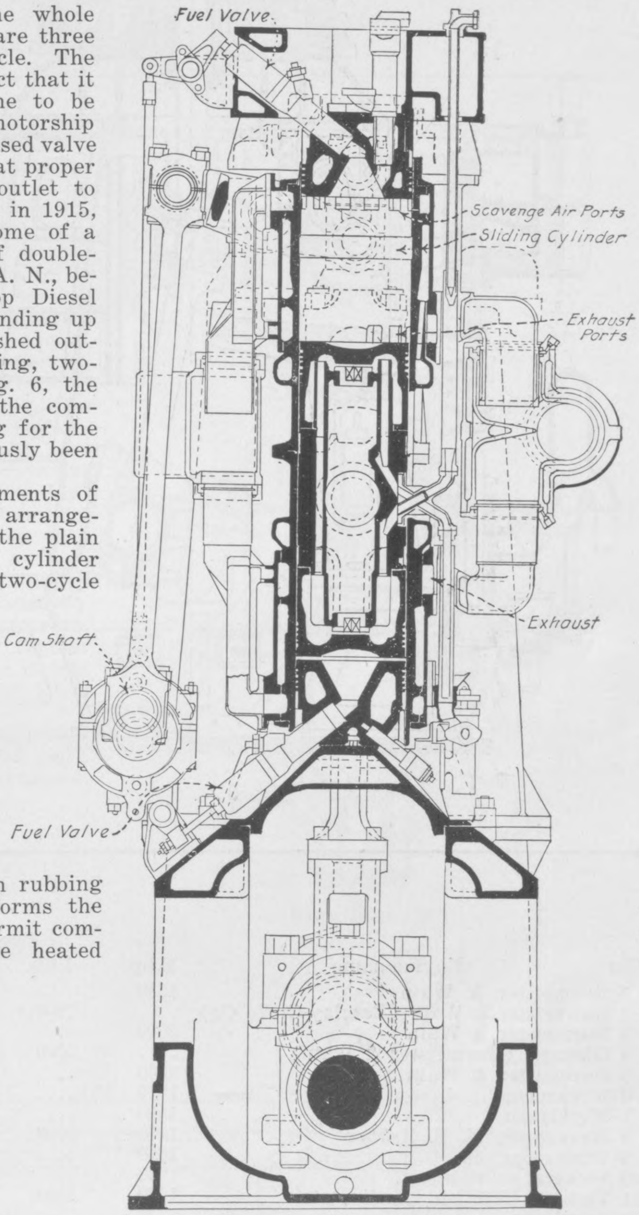


Fig. 3

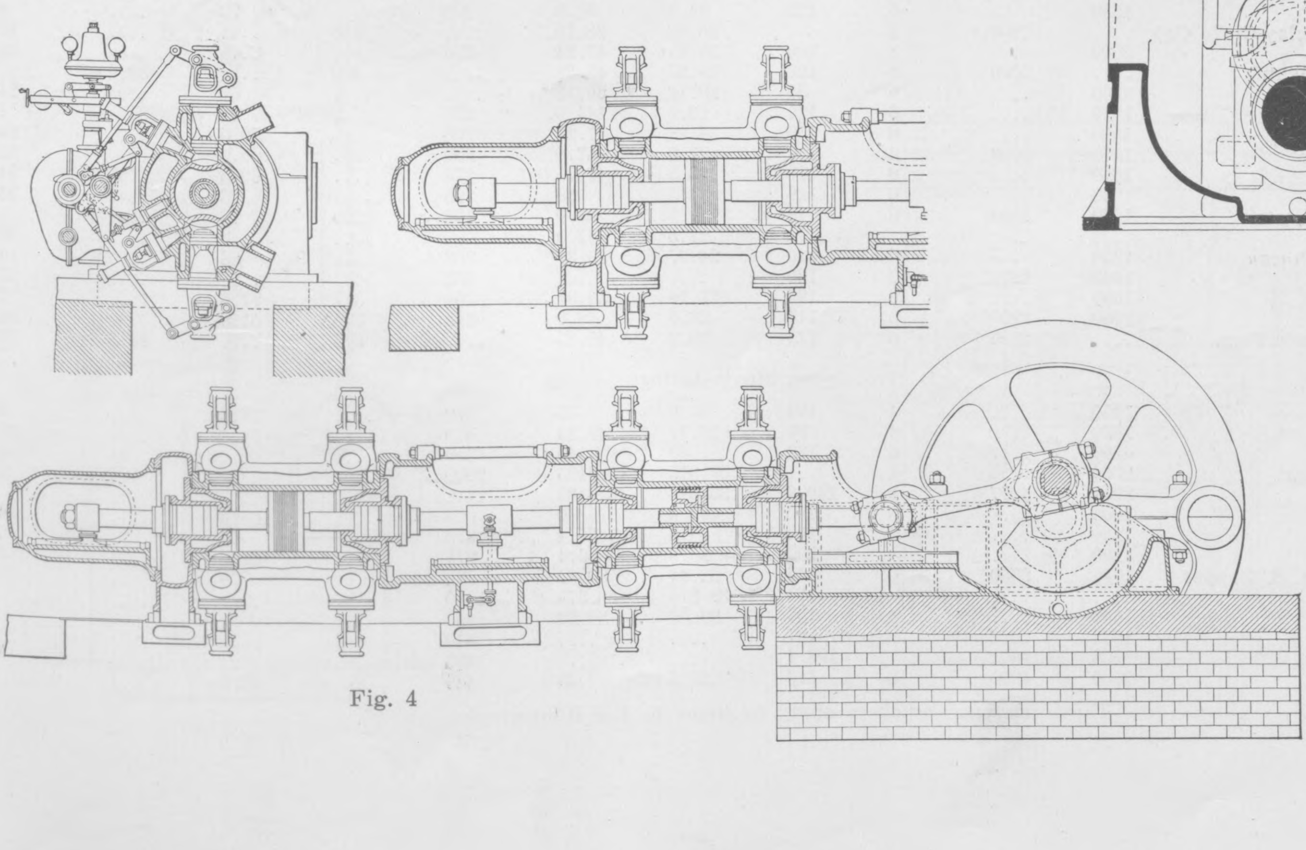


Fig. 4

*Continued from page 31, January issue.

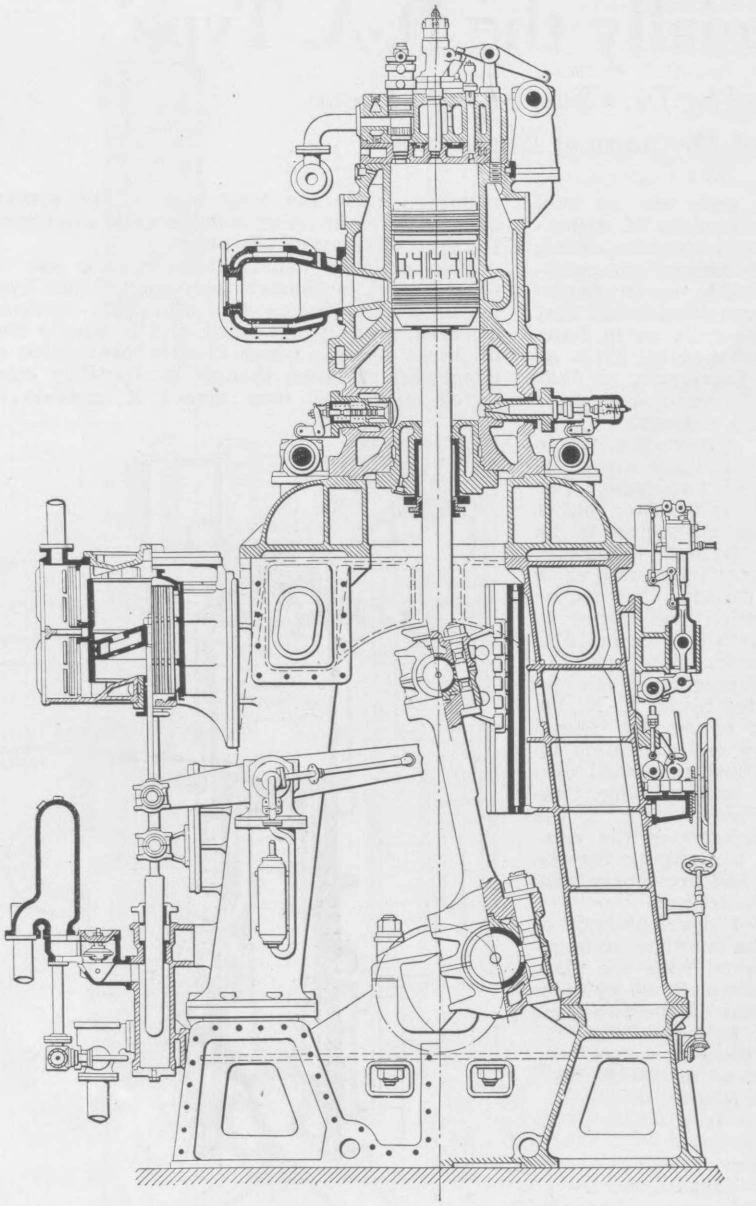


Fig. 5

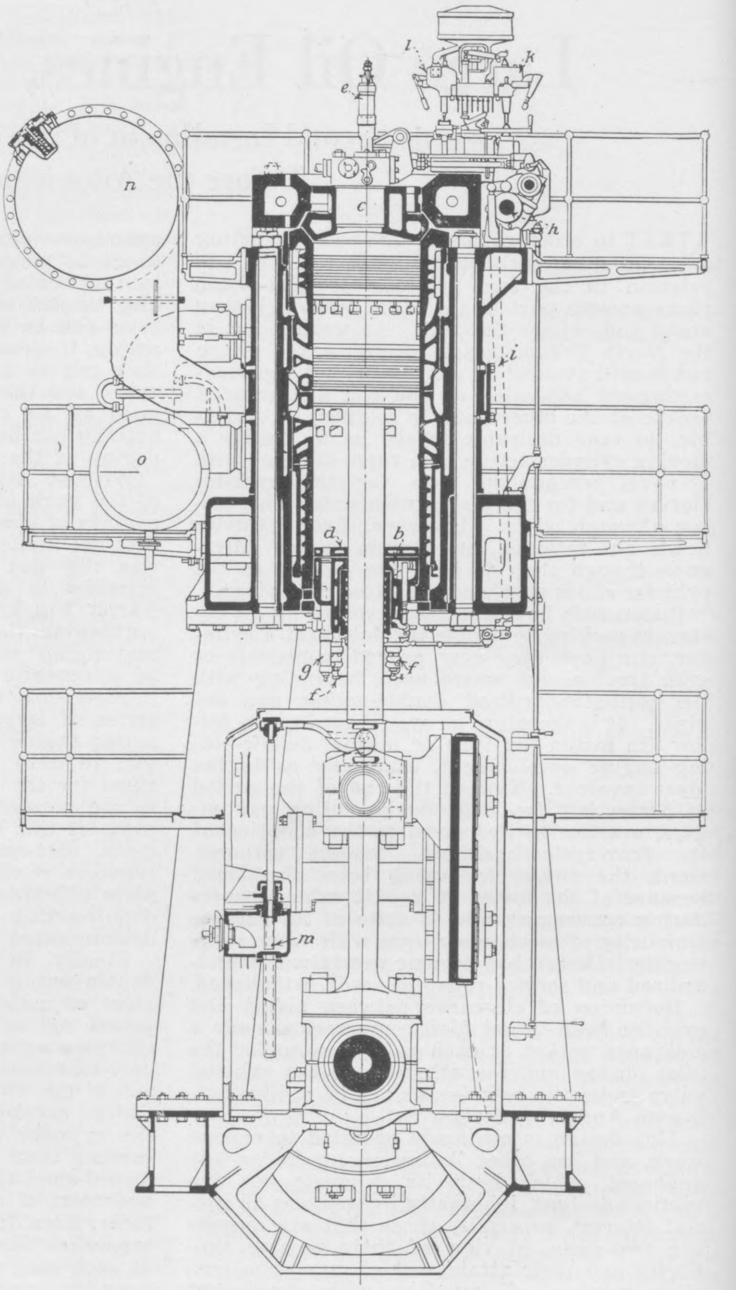


Fig. 6

TABLE 1 LARGE OIL ENGINES

A Four-Cycle, Single-Acting

No	Engine name	B.hp.	I.hp.	No. cyl.	R.p.m.	Bore, in.	Stroke, in.	Hp. per cyl. B.	Hp. per cyl. I.	Mean press. B.	Mean press. I.	Refer.*
1	Burmeister & Wain	1250	....	6	125	24.8	37.8	208	....	72	....	4
2	Burmeister & Wain (Barclay-Curle Co)	....	2500	8	....	20.88	28.75	....	313	....	....	10
3	Burmeister & Wain	3000	...	8	100	31.49	47.24	375	....	80.5	....	34
4	Glenapp (Burmeister & Wain)	....	3200	8	120	29.53	43.31	....	400	....	89.2	....
5	Burmeister & Wain	1750	....	6	85	29.12	50.12	....	....	63	....	24
6	Werkspoor	1250	....	6	125	23.0	41.0	208	....	77	....	4
7	Werkspoor	1560	....	6	110	26.38	47.24	260	....	72.5	....	34
8	Werkspoor, M. S. *Ashbee*	1500	2000	6	110	27.0	47.0	250	333	66.6	....	36
9	Werkspoor	1650	....	6	110	26.5	47.25	275	....	69.5	....	24
10	Vickers, solid inject.	1250	...	6	118	24.5	39	208	....	76	....	33
11	Vickers, Scottish Mardin, etc	1250	1560	6	118	24.5	39.0	208	260	76	....	....
12	Augsburg	....	..	.	....	27.5	47.0	....	....	....	....	30
13	Tosi-Beardmore, M S *Pinzon*	1250	.	6	120	24.37	33.37	208	....	88	....	10
14	Krupp	1400	1867	6	125	....	....	233	....	....	....	37
15	Motorenwerke-Mannheim	1600	...	6	120	27.16	39.37	267	317	77.5	....	2
16	McIntosh-Seymour	1700	2250	6	115	28.0	48.0	283	375	61.3	....	36
17	Cramps (B. & W), Wm Penn	....	2250	6	115	29.2	45.25	....	375	....	85.5	35

B Two-Cycle, Single-Acting

No	Engine name	B.hp.	I.hp.	No. cyl.	R.p.m.	Bore, in.	Stroke, in.	Hp. per cyl. B.	Hp. per cyl. I.	Mean press. B.	Mean press. I.	Refer.*
1	Sulzer	1250	....	4	102	23.6	37	310	....	76.3	....	4
2	Sulzer	1800	...	4	90	26.77	47.24	459	....	71.5	....	32
3	Sulzer Stationary, 1915	4500	....	6	132	30	40	750	....	....	94	3
4	Sulzer Experimental, 1914	2000	...	1	....	39.375	43.3125	2000	....	...	122	3
		2058	3297	1	149.6	39.375	43.3125	....	...	....	...	....
5	Sulzer	4000	...	6	100	32.0	48.0	666	....	68.5	....	34
6	Ansaldo, San Giorgio	1250	....	4	110	24.8	35.4	310	....	66	....	33
7	Ansaldo	1100	....	4	100	25.8	35.4	275	....	64.0	....	34
8	Germania Werft, Kiel, M S. *Zoppot*	1675	2360	6	106	22.64	39.37	280	....	70	....	2
9	Carels (1911)	....	....	...	150	38 375	38.375	1250	....	....	....	....
10	Nobel, Swedish	1600	....	4	106	26.58	36.22	400	....	....	....	....
		1635	2022	..	107	....	....	410	....	....	...	2
		1958	2401	....	108.4	....	....	490	....	...	....	....
11	Bethlehem	2900	4000	6	116	25.5	48	480	....	67.5	....	....

* These reference numbers apply to items in the Bibliography.

TABLE 1 LARGE OIL ENGINES—CONTINUED

No.	Engine name	B.hp.	I.hp.	No. cyl.	R.p.m.	Bore, in.	Stroke, in.	Hp. per cyl. B.	Hp. per cyl. I.	Mean press. B.	Mean press. I.	Refer.*
	C Two-Cycle, Opposed-Piston and Rodless, Double-Acting											
1	Palmer-Fullagar	3000	....	6	90	23	36	500	....	73.5	....	32
2	Cammellaird-Fullagar	1250	....	4	125	18.5	25	310	....	71	....	4
3	Doxford	2610	3050	4	76.7	22.375	45.5	650	....	90	....	33
4	Doxford	1850	....	3	85	21.25	42.5	615	....	99	....	32
	D Four-Cycle, Double-Acting											
1	M. A. M.	1600	....	2	....	23.33	31.50	800	....	....	....	5
2	N. E. Werkspoor	600	....	1	95	31.5	55.0	600	....	58.0	....	32
3	Burmeister & Wain	6750	8150	6	....	33.0	59.12	1130	....	70	....	32
	E Two-Cycle, Double-Acting											
1	North British	2000	....	3	100	24.5	44	667	....	63	....	38
2	Durenberg, 1910	12000	....	6	160	33.46	41.34	2000	....	....	....	2
	Valve Scaven.	3220	....	1	145	33.46	....	....	3573	....	144	....
3	Blohm & Voss, M. S. *Fritz*	850	....	3	110	18.9	27.95	283	....	75	....	39
4	M. A. N.	2000	....	3	75	27.5	46.25	667	....	63	....	32
5	Worthington	2900	....	4	95	28.0	40.0	2900	....	64.8	....	....

* These reference numbers apply to items in the Bibliography.

greater resistance even if such were present. It is therefore capable of safely carrying very much higher rates of heat generation than one of cast iron for a given bore, and as a consequence may safely carry such rates as are characteristic of larger bores than are possible for cast iron.

Some items of interest, including the relation of fuel consumption to size and arrangement of large oil-engines, are now to be examined in a more analytical way after reviewing some of the notable large engines that have been built. The main data of some of these engines are collected for easy reference in Table 1. Of these large engines there are two that stand out as of maximum interest in connection with size, both being experimental machines and each the biggest of its kind.

The first of those is the experimental Sulzer engine of 2000 b.h.p. in one cylinder, tested by Dr. A. Stodola[1] in 1914, a single-acting, port-scavenging engine. It developed 2058 b.h.p. or 3297 i.h.p. for 6 hours at 149.6 r.p.m. with a mean indicated pressure of 122 lb. per sq. in. or 159 lb. per sq. in. on effective stroke with a high scavenging air pressure of 7 lb. per sq. in., and at 4.55 lb. per sq. in. the mean pressure was 110 lb. per sq. in. or 143 lb. per sq. in. on effective stroke.

The other is of the Nuremberg engine, also experimental, of 12,000 b.h.p. in 6 cylinders, or 2000 b.h.p. per cylinder at 160 r.p.m., reported by Prof. A. Naegel[2] to have operated at loads of 10,800 to 12,000 b.h.p. for five days continuously during a period of three months of trials. Other tests of one cylinder in 1917 carried 3573 i.h.p. at 145 r.p.m. with a mean indicated pressure of 144 lb. per sq. in., and a friction loss of 10 per cent or 14.4 lb. per sq. in., exclusive of scavenging and compression, which were separate. This, like the former engine, was a two-cycle one, but unlike it was double-acting and valve-scavenged, and 33.46 in. by 41.34 in.

Neither of these high-capacity engines ever came into commercial use, but from them much information of great value has been obtained.

(*To be continued*)

1. The Development of the Sulzer Engine, By L. S. Le Mesurier, Inst. Mech. Eng., January, 1923.
2. The Diesel Engine of Today, A. Naegel, Zeit. Ver. Deut. Ing., June, 1923.

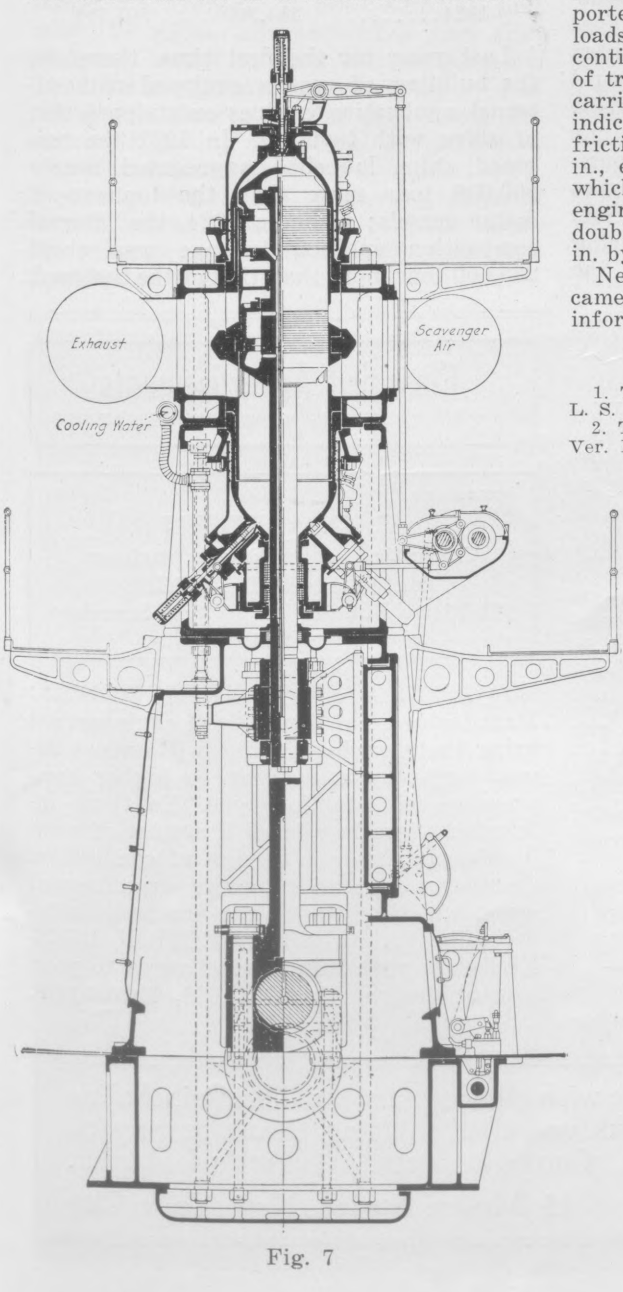
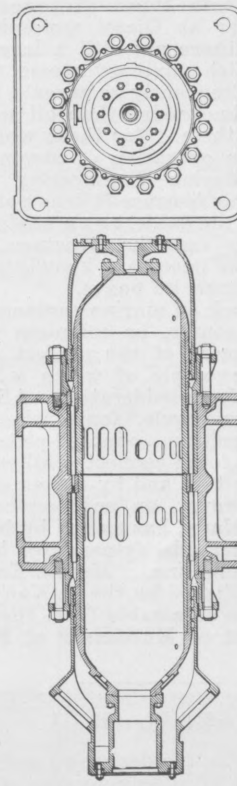


Fig. 7



Figs. 8 and 9

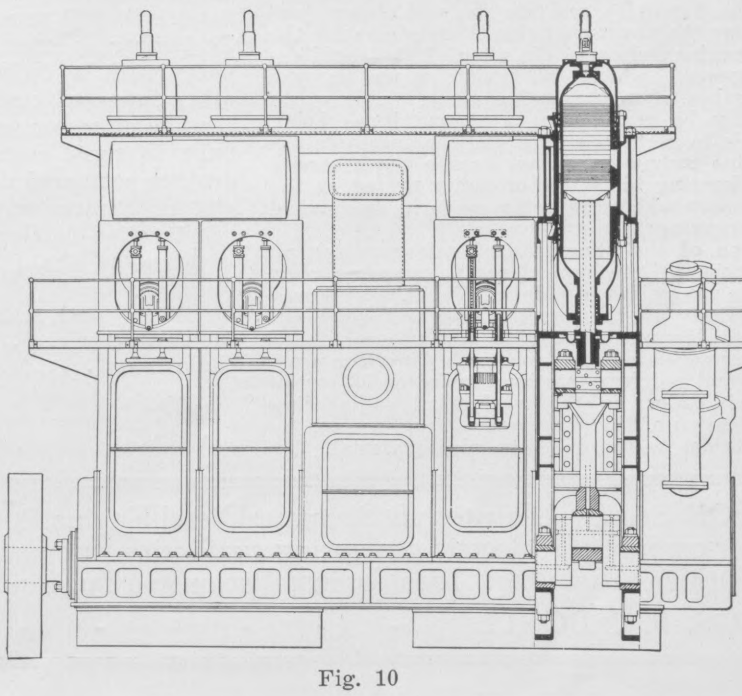


Fig. 10

Review of Recent Publications

Marine Engineering Practice

As a general text-book on the different varieties of machinery encountered in the propelling plants of ships, "Marine Engineering Practice" meets the need for a treatise that is thorough without being cumbersome and scientific without being professorial. For the men who make ships go, many excellent books on marine machinery are unsuitable because they treat the subject in a contemplative manner that speculates about origins and developments rather than furnishing a present-and-actual store of information. The latter shortcoming has been completely avoided by the author of "Marine Engineering Practice" and he has contributed notable positive improvements to the art of writing real marine engineers' text-books.

Although motorships are displacing steam vessels at an ever-increasing rate, there is still plenty of use for steam engineering knowledge and the book here described gives a good overall survey of both types of propelling machinery. As far as Diesel motorships alone are concerned, there are still a large number of them on which auxiliary steam machinery is used and it frequently requires a more specialized steam knowledge than oil engine proficiency to run them. For those who are concerned with the operation of steam-auxiliary motorships, "Marine Engineering Practice" would be of value because it does not treat the steam phase of the subject as a student of natural history analyzes the structure of a beehive. Useful and necessary knowledge may be taken directly from its pages.

No modern book on marine engineering practice would, of course, be complete without a thorough treatment of the subject of oil engines, a good example of which is furnished by the book under consideration. All the various types of two-cycle, four-cycle, air-injection, surface-ignition, opposed-piston, direct reversible, and clutch-connected oil engines are described in the text and by means of illustrations. F. J. Drover, an engineer-commander in the English Navy, has shown by his method of treatment that oil engines have been more to him than a side line. "Marine Engineering Practice" is published by the D. Van Nostrand Company and is obtainable from the technical book department of MOTORSHIP at $6.50, plus postage.

Marks' Handbook

Specialization in the designing and manufacturing technique of oil engines has of late been carried to such an advanced stage that it is regarded by some as a separate art. There is justification for this attitude only if it be postulated in advance that the parent branches of mechanical engineering, such as machine shop and foundry practice, applied hydraulics, thermodynamics, and the like will always persist as the never-changing foundations for the oil engine industry. In view of the rapid development which is taking place in the branches of mechanical engineering, it would hardly be reasonable to regard it as being static to such an extent and the successful oil engine technician cannot escape the necessity for keeping himself thoroughly posted on the advances which are being made in mechanical engineering as a whole.

One of the standards of reference for all branches of mechanical engineering has come to be recognized in "Marks' Handbook." Based originally on the encyclopædic and super-scientific European works of this nature, it has been revised in accordance with American practise and requirements by a board of 58 recognized leaders in the mechanical engineering profession of this country.

Besides containing live-wire material, this book of nearly 2000 pages is arranged, indexed, and cross-indexed in a thoroughly practical and systematic manner that makes it an efficient tool in the hands of the busy mechanical engineer. The most out-of-the-way little item of special information can be located with astonishing rapidity. Mathematical tables showing the same efficiency of arrangement are given and are capable of rendering time-saving assistance in the carrying out of a wide variety of computations.

The Diesel engine section belongs to the best in the book, being profusely illustrated and clearly written. Unlike most general mechanical engineering works the book does not treat oil engines as a side issue, but describes them in all their various phases in a way that would be hard to duplicate for accuracy and completeness.

"Marks' Handbook" is published by the McGraw-Hill Book Company and is obtainable through MOTORSHIP technical book department, price $6.00, postage extra.

World's Motorship Construction

Lloyd's returns for the last quarter of 1924 show a decrease in the world's shipbuilding activities as compared with the previous quarter, but compared with the end of 1923 the figures are virtually the same.

Construction of motorships continues to play a prominent part in the returns for world shipbuilding. While there has been a slight decline (16,000 tons), as compared with the quarter ended Sept. 30 last, the decrease in construction work on other types of vessels during the same period amounted to 94,000 tons. The proportion of world construction represented by motor vessels is now 37.4 per cent, as contrasted with one per cent less in the previous. The comparison between motor vessels and other types of ships under construction during the last two quarters is shown by the following table covering the total world building, the figures representing gross tons:

	Dec. 31, 1924	*Sept. 30, 1924*
Motor vessels.......	923,738	939,899
Other types.........	1,546,698	1,641,113
World total.......	2,470,436	2,581,012

The slight decline from the total motorship construction for the previous quarter is due to the general shipbuilding decrease in Great Britain and Ireland, where Lloyd's returns show motor tonnage in hand is 67,000 gross tons less than in the September quarter. This, however, compares with a decline of 227,000 tons in other types of construction, and the percentage of motor vessels to the total being built in these countries is now 27.4 per cent, as compared with 26.4 per cent at the end of September. The division of the construction in Great Britain and Ireland is given in the following table of gross tonnage:

	Dec. 31, 1924	*Sept. 30, 1924*
Motor vessels.......	320,137	387,670
Other types.........	853,328	1,080,738
Total	1,173,465	1,468,408

While the construction work of the other maritime countries shows an increase over the previous quarter in both motor vessels and other types, the gain has been more pronounced in other types of propulsion, these increasing 133,000 tons, as contrasted with an advance of 51,000 tons in motor vessels as the following table shows:

	Dec. 31, 1924	*Sept. 30, 1924*
Motor vessels.......	603,601	552,229
Other types.........	693,370	560,375
Total	1,296,971	1,112,604

The result is that motor vessels now represent 46.6 per cent of the total construction in the smaller maritime countries, as against 49.6 per cent in the previous quarter.

A Lloyd's Comparison of Motive Power

Another decline in the launchings of vessels equipped with turbines is shown by the returns for 1924. While the gain in motorship construction as compared with the previous year was 275,000 tons, the total for turbined vessels shows a drop of about 20,000 tons, states another Lloyd's report. The contrast between the two types of vessels for the past few years is shown in the following table of tonnage launched:

	Turbines	*Motor Ships*
1921.........	1,195,000	306,000
1922.........	776,000	209,000
1923.........	304,000	226,000
1924.........	284,700	501,798

Last year, for the first time, therefore, the building of vessels equipped with internal combustion engines outstripped that of ships with turbines. In 1921 the turbined ships launched aggregated nearly 900,000 tons more than the tonnage of motor vessels; while in 1924, the internal combustion engined tonnage was about 225,000 tons more than that of the turbined.